Florida Trends and Conditions

2000 – 2001

Trends in Transportation and Land Use

Prepared for:
Florida Department of Transportation

Prepared by:

FAU/FIU JOINTCENTER for Environmental & Urban Problems

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Executive Summary

"Trends in Transportation and Land Use," a chapter of the report entitled *Florida Trends and Conditions 2001-2002*, discusses the relationship between transportation and land use and how changes in one has affected the other. The findings in this chapter are meant to support the development of the *Florida Trends and Conditions Report,* a publication of the Florida Department of Transportation.

"Trends in Transportation and Land Use" begins by setting the transportation and land use link in a historical context for the state of Florida. It then proceeds with a detailed discussion on the present and future trends of these elements, both of which greatly affect growth and development patterns within the state of Florida.

The first section of this chapter examines the various forms of transportation that have evolved throughout the state, and how land and water have impacted the evolution of the various modes of transportation. The report then discusses how Florida's land has transitioned from swampland to developable land, and in present times how rural and agricultural lands are being pressured for conversion to urban development. A key factor in the development of land and transportation infrastructure is the demand produced by the state's rapidly increasing population. The second part of this chapter examines the changes in Florida's population, its settlers, and settlement patterns. This leads into the analysis of transportation and land use needs and how these needs also affect population densities throughout the state. The final section of this chapter looks at the regional issues and trends the state presently faces, and then moves forward with a discussion of future challenges and trends.

The key findings of the study are:

- Florida experienced its most intensive growth between 1960 and 1990, which coincides with the development of the Florida Limited Access Highway network funded by the 1956 Federal-Aid Highway Act.

- During this time, nearly 150,000 acres of Florida farmland were developed each year.

- Water, as a feature and resource, has been a major factor in the development of the land use/transportation relationship in the state by driving the tourism-dependent economy, as well as providing a means for local and international transportation.

- Until recently, urban growth and intensity of development have been highest in coastal areas. This has been closely related to accessibility of the state's highway corridors, proximity to waterfront, and growth management policies directed at promoting or containing growth within boundaries.

- Although population and density continue to be greater in coastal areas, growth is no longer confined to coastal counties.

- In addition, encroachment of the coastal areas, protected water sources, and other related natural features, such as wetlands, are limiting urban growth and development in areas where development has traditionally taken place.

- Growth is moving to the rural areas where land is relatively cheap and growth management policies are less stringent, thus promoting sprawl development.

- Finally, in non-coastal regions of Florida, other economic generators—universities (Gainesville), manmade tourist attractions (Orlando)—have generated major transportation infrastructure investments (major highways and airports) attracting new development.

The key findings tell a story of how Florida has developed into the state we know today, and reveal the major factors that will shape it into the state we will know tomorrow. From the major findings of this report, it can be concluded that as Florida's population continues to grow, innovative ways must be developed to deal with population growth, sprawl, congestion, and mobility issues. The key findings also clearly suggest that more interactive and innovative techniques must be developed in the planning stages of transportation and land use to link the two more efficiently. Although transportation has always been a part of state and local comprehensive plans, serious emphasis has not been placed on the development

of transportation systems or alternative modes of transportation that address urban form or community design.

Florida Statewide Trends in Land Use Patterns

Historically, Florida's urban settlement and growth patterns are related to the state's geographical relationship to water. Yet in more recent history, the development of roads has joined the mixture of development factors. The mixture is not unusual because of the interconnectivity of water, land use, and transportation in Florida. Over the decades, water has played a major role in the state's land use and transportation infrastructure development. Serving as both an obstacle and an amenity to land use and transportation needs, it has driven development in some areas while virtually halting it in others. Historically, traveling by water was the earliest means of transportation. Port cities later became indicators of where to place road and railroad infrastructure, as port cities were the first signs of urbanization within the state. By looking at land use, transportation and the water component, we are presented with a clearer picture of urban growth, land use, and transportation trends in Florida.

Before 1845, Florida settlers had depended on ships and the state's seaports for their transportation needs because traveling by water was safer and more efficient than traveling by land. In 1845, the construction of railroads initiated the process of opening Florida for development. However, railroad construction had been hampered by the state's swamp-like conditions. Florida's conditions convinced the federal government to turn over 20 million acres of what it had considered useless land to the state through the Swamp and Overflowed Lands Act of 1850. Florida's newly acquired land began improving after the state legislature passed the 1855 Internal Improvement Act. The Act offered inexpensive or free public land to investors in an effort to spur economic development and population growth while encouraging the development of new railroad and canal transportation routes.

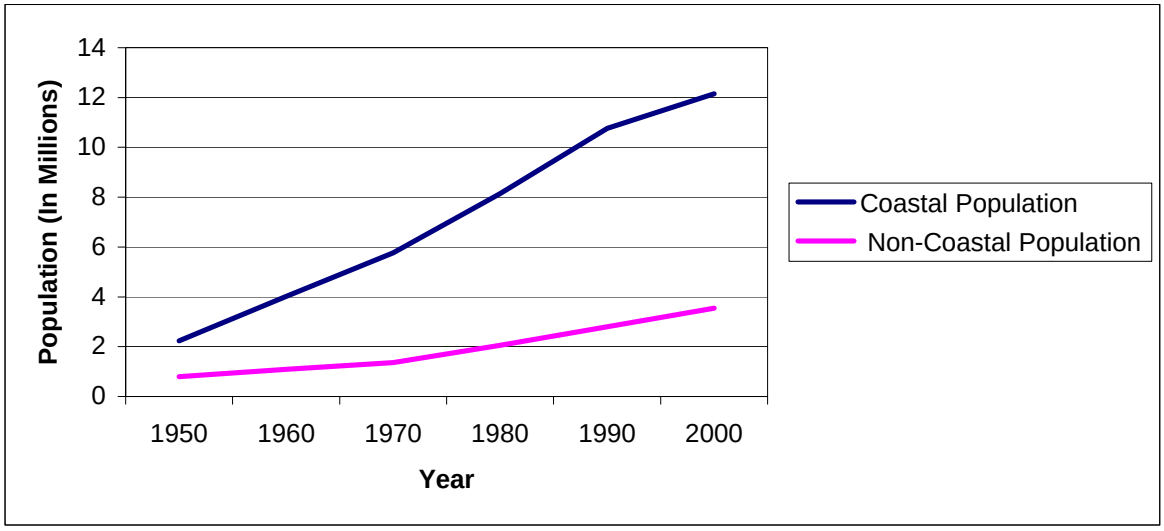
Entrepreneurs and opportunists accepted the offer and capitalized on it. During the period between the Civil War and the beginning of World War I, railroads were constructed throughout the state, along with a few lavish hotels; a foreshadow to the tourism industry that would follow. After the Civil War, mineral springs and the state's warm climate began luring visitors who indulged in the state's few existing ferries,

railroads, and hotels. By the late 1880's and 1890's railroads were connecting Florida to northern states.[1]

Opportunists also realized the natural resources inherent within the state's soil. While some ventured into mining minerals such as phosphate, others ventured into draining the land for agricultural purposes. Draining swampland in south Florida was the dominant approach to land and water management until the 1940s. [2] Extravagant efforts were made to convert swampland into farmland and developable land, especially in the south. Over 65 percent of Florida's Everglades were drained before environmentalists realized the detrimental effects draining and altering water flow patterns had on the state's ecosystem.

Draining land made vast areas of Florida suitable for development throughout the entire state. However, the coast has been a driving force behind urban development and settlement in Florida. Florida, with approximately 8500 miles of shoreline, has the second largest coast in the United States. More than 10 million Floridians live in the state's 35 coastal counties.[3] As growth within the state increases, it is expected that eventually about 80 percent of new Floridians will live within 20 miles of the coast.

Figure 1: Change in Population Coastal Counties Vs. Non Coastal Counties Between 1950 and 2000.[4]



The numbers reflect that the coast has been a waterfront amenity and an economic booster to the state. Florida's beaches are the most valuable pieces of real estate property in the state. They cost more per foot, per waterfront, and contribute more to the state's economy than any other real estate. The coast also attracts more than 40 million tourists and more than $17 billion dollars in revenue per year.[5] Early developers saw its potential and propelled the demand for development to an enormous pace around Florida, especially in the southeastern Atlantic Coast. Born from this era were Florida cities such as Miami Beach, Coral Gables, and Ft. Lauderdale.[6] Hence, this was the beginning of the development of Florida's southeast coastline. Florida's coast has proven to be economically beneficial to the state and has withstood the various patterns and migration of development.

Today, Florida's urban landscape is characterized by pearl-necklace development strung along the extensive coastline where much of the land use is hotel, residential, and recreational. The spine of the eastern strand of cities and towns is composed of highway US 1 and the CSXT Corporation railroad. Interstate 95 and the Florida Turnpike were added later and provide greater mobility throughout the central and southeastern parts of the state. The western strand of communities line highways US 41 and US 19, north of Tampa. With the construction of Interstate 75, capacity was added from Broward County in the southeast, across the state, and up to Ocala. Tourist development in the Panhandle can be found along US 98.

In contrast, small towns that grew away from the coastline and towards the center of the state have remained mainly rural. These centrally located rural towns have been dependent upon the forest and agricultural landscapes. North Florida and the panhandle, alone, contain cattle farms and crop fields in addition to 7 million acres in tree farms and several million more acres in state or national forests.[7] Small farm towns developed around Lake Okeechobee in South Florida, and around Lake Apopka in north Florida. Historically, central urbanization has been sparse with towns strung loosely along US 27, US 90, and Interstate 10. In the metaphorical string of pearl

necklace development, Interstate 10 is the clasp connecting the state to the Capital, while bridging the east and west urban coasts to central rural communities.

Florida's Transportation Connection

Florida has consistently dedicated funds to transportation infrastructure throughout its short urban history. Internal transportation depended mainly upon an all-state system of railroads and canals. Steamboats provided access from the coast to parts of the hinterlands through a complex system that connected rivers and lakes by way of manmade canals. By the early 1900s, changing priorities halted the construction of additional barge canals focusing the use of canals for flood control. Railroads, mainly to the central parts of the state and the panhandle, provided freight transportation for agricultural goods and timber. By 1890, Henry Flagler began transporting tourists along the east coast on his railway, which connected all the way south to Key West by 1905.[8]

The state road department was established in 1915. By 1916 the Bankhead Act was passed by Congress expanding the department's responsibilities and giving it the authority to: establish a state system of roads; engage in road construction and maintenance; acquire and own land; exercise the right of eminent domain; and accept federal or local funds for use in improving roads.[9] In 1917, the state was ordered to establish an intercity road network of state highways. By 1938, state and Federal funds had built 9,000 miles of roads. Major roads such as US1, US 27, US 19, and US 98 were products of the established road network.

To promote the movement of goods and interconnectivity of states, the Federal-Aid Highway Act of 1956 was passed marking the beginning of a national high-speed limited access interstate highway system. Construction on most of the larger highways in the state, such as Interstates 10, 4, 95, 75, started after the passage of this Act. By the early 1960's, sections had already been completed. The 1956 Act added capacity to this already existing road network. The creation of this highway system paralleled Florida's population and urban growth. It not only connected regions of the state and

moved goods to other states, but also opened up doors to new development opportunities as hundreds of miles of undeveloped land ran alongside highways and their access ramps. Roads, unlike waterways and railroads, provide direct and frequent connections to the surrounding land opening up greater opportunities for development. However, with all of the new development, roads like US 41 and US 19 that were once interregional highways have now effectively become, in urbanized areas, slower speed local arterials.

In the 1970's the state's increasing population concentrated mainly in southeastern Florida between West Palm Beach and Miami. Large sections of I-95, which now extends along the entire east coast of Florida, had been added to provide greater road capacity. The entire highway had been completed in 1987. Unfortunately, while adding capacity, the construction of I-95 and other highways in the state like I-275 (Tampa) and I-10 (Jacksonville), literally divided some vibrant urban communities with detrimental effects.

Another major highway, US-27, was the major route between central and south Florida until the construction of the Florida Turnpike (1957). The Florida Turnpike completed its final extension from Miami to Homestead in 1972. This toll-way runs mostly parallel to I-95 providing an alternate route between south and central Florida. By the late '90's, urban concentrations extended almost continuously up and down the southeast coast between Miami and Melbourne.

The relatively newer highways such as I-4 and I-75 were constructed to connect Florida's coastal urban areas. They have emerged to be magnets for urban growth in once exclusively rural areas. The central region of the state lies among a transportation hub, with two international airports and connects to port systems on both the Atlantic Ocean (Cape Canaveral) and the Gulf of Mexico (Tampa).[10] The Orlando area alone includes two airports with international flights in Orlando and Sanford. Man-made tourist attractions have made this a major urban center drawing over four million tourists a year to the area.[11] In addition, this area of the state is the home to big name Florida

universities. Central Florida offers access to mild weather, beaches, lower cost of living, and lower property taxes. Growth in the area is being pushed both privately and publicly.

Officials from the University of South Florida (Tampa) and the University of Central Florida (Orlando), along with economic development organizations and corporate executives throughout the central 13-county region, have formed a coalition described as the Florida High Tech Initiative. The Florida High-Tech Corridor Council has attracted nearly $1 billion in private investment in 13 counties.[12] The situation is the same just to the north of Orlando, in Gainesville. The city, which lies just off of I-75, has been growing at an enormous pace with cheap agricultural land being converted to land for urban development at an alarming rate. Much of the new development can be found lining transportation corridors connecting with other major urban centers.

Today, Florida is criss-crossed by millions of miles of major and minor highways connecting all of the major cities. Limited access highways are found running north and south along the east and west coasts, and cutting east and westwards at three key locations: south between Ft. Lauderdale and Naples, central between Daytona and Tampa, and north between Jacksonville and Pensacola.

Florida Lands in Transition

Of Florida's 35 million acres of land, 66% is used for agriculture and forestry.[13] Urban growth is no longer primarily confined to coastal counties or directly along the shoreline. It has manifested itself upon rural communities as well. Between 1960 and 1990, nearly 150,000 acres of Florida farmlands were converted to development each year.[14] In 1990, about 19 acres per hour of forest, wetland and agriculture were being converted for urban purposes.[15] As more land is consumed, the demand for agricultural lands in transitional locations close to urban development continues to increase.[16] Transitional lands, as defined in a University of Florida study, is agricultural land that is being

converted or is likely to be converted for nonagricultural uses, such as home sites, subdivisions, or commercial development.[17]

The pressure to convert land stems from both population growth as well as economic growth. Land use planners that consider putting land to the highest and best use will view urban development as the best use for remaining agricultural land. However, rural and farming areas, fragmented by suburbs, in addition to rising land costs, leave farmers and ranchers torn between the desires to continue farming or to maximize the value of their land.[18] The amount of land that has been converted each year is an example of the few incentives that farmers have to withstand selling their land to developers. With this stage, some have observed that the last crop a farmer would like to plant before retiring is a row of condominiums.[19] As long as both types of growth continue, rural lands, both agricultural and transitional, will continue to be under pressure for conversion in both central and coastal counties.

The pressures being placed on Florida's agricultural lands are significant to the state's and the nation's economy. Within central rural communities lie powerful economic engines for the state: agriculture and timber. Florida ranks ninth out of fifty states, in cash receipts from farming. Of 24 million acres of farmland, 33% are used as cropland, 22% as timber forests, and the rest are dedicated to pasture and other uses. The agricultural community maintains large-scale commercial citrus and sugar industries that make it just as important economically as coastal land. In addition to citrus, sugar, and cattle, more than 5.4 million acres of woodland is owned by the forest industry. In 1998, the citrus harvest was worth $1.2 billion, sugarcane was valued at $500 million[20], and the timber harvest was worth approximately $752 million.[21] The forest industry will continue to gain importance as the demand for solid wood is closely tied to housing starts.[22]

Historically there have been fewer farms in south Florida than in north Florida, yet south Florida farms have been larger and produced over three-quarters of the state's total agricultural sales.[23] In southeast Florida, as development has sprawled

west, it has consumed thousands of acres of agricultural land. This phenomenon, topped with oversea competition in citrus production, has caused the value of agricultural land in south Florida to decrease over the years while grain, tree, and cattle producing agricultural land in the northern parts of the state has increased. The top counties for agriculture have been Palm Beach, Polk, Hendry, Hillsborough, Miami-Dade and Orange, all of which are experiencing urban population growth pressures.[24]

Florida's increasing urban growth prompted the enactment of legislative polices such as the Growth Management Laws of 1972, 1985, and 1991, the Warren S. Henderson Wetlands Protection Act of 1984, and the Preservation 2000 Act passed in 1990. The laws were deemed necessary because the uncontrolled urban growth was draining, dredging, and filling wetlands while threatening critical sources of portable water. These policies were enacted to regulate development and effectively manage the provision of services to accommodate urban growth. Moreover, they were catalyzed by the desire to protect Florida's environment and quality of life. The construction of local roads and highways, along with the development of new suburban and exurban cities, has destroyed a great amount of the state's wetlands and fragmented natural habitats causing the demise of native species unique to the state.

Florida's Growth Management laws have had influence on the location of urban growth within the state of Florida. The 1972 Environmental Land and Water Management Act addressed "areas of critical concern" and "developments of regional impact." Areas that were designated as "areas of critical concern" such as the Big Cypress Area, the Florida Keys, Apalachicola Bay and Green Swamp are under protection because of their great potential for development and the impact their presence has on the surrounding environment. Developments of Regional Impact (DRIs) regulate large projects that are likely to have impacts on an area greater than the communities that control them.

Perhaps the most influential of the growth regulation laws listed above is the 1985 Growth Management Act. It gave the state power to regulate local government's

compliance with growth management laws. It strengthened the state's land development regulations and enumerated transportation level of service standards. Later it would be noted that the Growth Management Act did little to curb Florida's sprawling urban growth. The Act's concurrency regulations indirectly undermined the state's efforts to discourage urban sprawl. Many development projects could not meet the expense of adding road capacity to congested roads in already urbanized areas. Therefore this gave developers another reason to move to outlying parts of urbanized areas, with cheaper land, thus contributing to urban sprawl.[25]

The Wetlands Act, meanwhile, gave the Department of Environmental Protection the authority to regulate dredging and filling of state surface waters including wetlands. It was passed to protect environmentally sensitive wetland areas and designated areas of critical state concern. In an effort to offset wetland destruction where possible and improve deteriorating wetland, the department was also given the power to approve mitigation in development projects throughout the state. Even though the Act has been touted as a major legislative achievement, just like the growth management acts, it has been criticized for its flaws. Most of the controversy has stemmed over mitigation efforts within the state. Some say mitigation efforts have resulted in net losses of wetlands because engineers have not been able to recreate or replace entire interconnected systems of wildlife.[26]

Whereas the Wetlands Act did not focus on conservation and preservation of natural areas, the Preservation 2000 Act (P2000), passed in 1990, did. By 1990, about 8 million acres or forests and wetlands had been cleared due to population and urban growth. The P2000, a $3 billion land preservation program had several purposes and goals. Funds were distributed for conservation and recreational areas, water resources, and local government comprehensive plan implementation to name a few. In addition, one of the program's goals was to catalyze local conservation efforts. More than 20 local governments in Florida have matched state funds to purchase environmentally sensitive lands for conservation.[27]

Through the state's Preservation 2000 land acquisition program, over 1 million acres of land were purchased and preserved. However, roads cannot be built through lands purchased with the program's funds. In recent years, some road expansion projects have faced opposition from local governments, which have designated environmentally sensitive land within their jurisdictions. Environmentally sensitive areas are not sustainable under the secondary and cumulative impacts of development, including road development.

In transportation projects, currently, secondary and cumulative impacts are evaluated, however the lack of requirements in legislation, formal procedures, and guidelines hinders standardization and comprehensive analysis in their beginning stages.[28] With not enough emphasis on secondary and cumulative impacts, some transportation projects have gotten tangled in costly delays and delayed permitted phases as environmental issues have been brought to the forefront.

Despite the amount of urban growth in coastal counties, the location of growth has remained relatively the same over the years. Current land use policies have left little room for drastic land use changes in the coastal counties. Sprawling suburban communities surround denser urban cores. However, the demand for low-density single-family residential development has prompted the infilling of sites once passed over by edge development. This process has produced higher overall densities relative to non-coastal counties.

The increase of population in coastal counties has been much greater than in non-coastal counties. Nevertheless, the most visible land use changes have occurred in the northern and central sections of the state, particularly around the cities of Gainesville and Ocala, and along I-4 between Orlando and Tampa, where there is pressure to convert rural and agricultural land for residential and industrial purposes to meet the urban growth demand of those regions. With more undeveloped land than their southern coastal neighbors, the north central and panhandle areas of the state are experiencing the most pressure for urbanized conversion.[29]

Who are Florida's Settlers?

Florida's urban growth is influenced by the difficult task of containing its population growth. The state's population growth has been primarily a result of in-migration and migration with net migration accounting for 88 percent of Florida's population growth.[30] Recent Census 2000 figures estimates that homegrown Floridians make up only 33 percent of the state's total population, while 7.4 million have migrated from other sates in the U.S.[31] Florida ranks second to last in native population.[32] Foreign-born residents grew from 13 percent in 1990 to 17 percent in 2000.[33]

The post-war years brought a steady rise in the population growth in Florida, attracting residents from across the United States as well as a large international population. Much of the growth has come from the relocation of retirees, workers, and their families from other states within the Nation, as well as citizens from other nations such as Cuba, Haiti, and Vietnam, all searching for a better quality of life. Many foreign immigrants are refugees from the Caribbean, Central and South American nations undergoing political or economic turmoil.[34]

Recently released Census 2000 figures suggest the number of retirees has decreased significantly in some Broward and Miami-Dade coastal communities. Many retirees who once saw these areas as their final destination no longer view them as a tranquil paradise. They are relocating to places such as Palm Beach County, Naples, and Central Florida.[35] Although Broward and Miami-Dade counties have been seeing a decrease in retirees, Florida, in general, has been known for its large retirement community. The state's census clearinghouse, the Bureau of Economic and Business Research (BEBR), has estimated that close to 18 percent of the population in the state was over 64 years in age by 1999 (versus 13 percent nationally).[36] According to Census 2000 figures, close to 18 percent of the state is still over 64 years of age.[37] In five out of 67 counties in the state this percentage was over 30 percent, including Charlotte, Citrus, Hernando, Highlands, and Sarasota.[38] Sarasota and Charlotte counties remain affluent retiree havens, populated by mostly working class retirees.[39] By 2020, it is expected that more than 25 percent of the state's population will be over the age of 65.[40] The

retiree market has not gone unnoticed by developers. Four major types of projects are developed for the retiree market: adult-only condominiums, beachfront high-rises, mobile home parks, and transitional to assisted-living retirement communities.[41]

Growth in the elderly population has made the need for certain types of public services more evident. Among the challenges is the need for appropriate transportation services to provide the aging population access to services and shopping opportunities. Vehicular accident rates are highest among the young and the elderly, who have few mobility options available to them. Insufficient public transportation, inadequate road design, and sprawled developments promote car dependence. Municipalities are just now devising ways to revamp transportation systems and development to be friendlier to the elderly and other populations with mobility impediments.

Other individuals have also been attracted by the relatively lower cost of living, favorable weather conditions, no state income tax, and job opportunities. Economic and population growth attract additional growth. Growth in jobs in construction, tourism, manufacturing, health, and elderly services has attracted new workers who in turn demand additional services increasing job availability. Accessibility to ports, airports and highways, in conjunction with low taxes and quality of life amenities, have helped to attract new industries. One notable example is the high-tech corridor that is evolving around the Interstate 4 corridor between Orlando and Tampa.

Florida is an international gateway. To the large populations of immigrants that come from the Caribbean and South America, the warm sub tropical climate of Florida is like home without the major political issues that caused them to flee their native countries in the first place. South Florida in particular continues to be a magnet for immigrants and a window on America's relationship with the Caribbean and South America.[42] Often immigrant populations settle among those who share their ethnicity. BEBR has estimated that the percentage of Hispanic population for the state of Florida was 16.3 in 1999. Of the 67 counties in Florida, five counties were above that percentage (Collier, DeSoto, Hardee, Miami-Dade, and Orange), and five of the counties had Hispanic populations greater than 100,000, including Broward,

Hillsborough, Miami-Dade, Orange, and Palm Beach. Miami-Dade's Hispanic population of 1,250,000,the highest in the state, makes up almost 60 percent of the county's population. Finally, 65 percent of the entire Hispanic population in Florida lives on the southeastern coast.[43]

Census 2000 figures show that the state is becoming more diverse, with large increases in Hispanic and black populations in various counties, including Broward and Palm Beach. These populations grew largely in part because of immigrants moving north from Miami-Dade or directly from abroad. Other regions in the state are experiencing this increase as well. Hendry County, known as Florida's sugar and citrus capital, had a demand for ready labor that drew thousands of Mexican and Central American farm workers to the country between 1990 and 2000.[44] Its population is now 40 percent Hispanic. Inland agricultural areas such as Immokalee in Collier County and Belle Glade in Palm Beach County have also attracted large numbers of black and Hispanic farmworkers.

Foreign immigrant settlement patterns in Florida have social, cultural, and economic dimensions. This is evident in the concentrations of Cuban, Haitian and Central American populations in south Florida. With them also come the comforts from home and innovations to the local economy and transportation. While stores stock products from their native regions and cater to specific tastes, the "jitney", a cross between a taxicab and a minibus, offers a new option of public/private transportation. In Miami-Dade County, jitneys are legally authorized by the same regulatory agency that oversees taxis. Once only common to Caribbean nations, there are now over 100 jitney services operating in the County. This form of transportation and its deep-rooted history has become a popular alternative to mass transit in Miami-Dade County.[45]

Intensity and Density

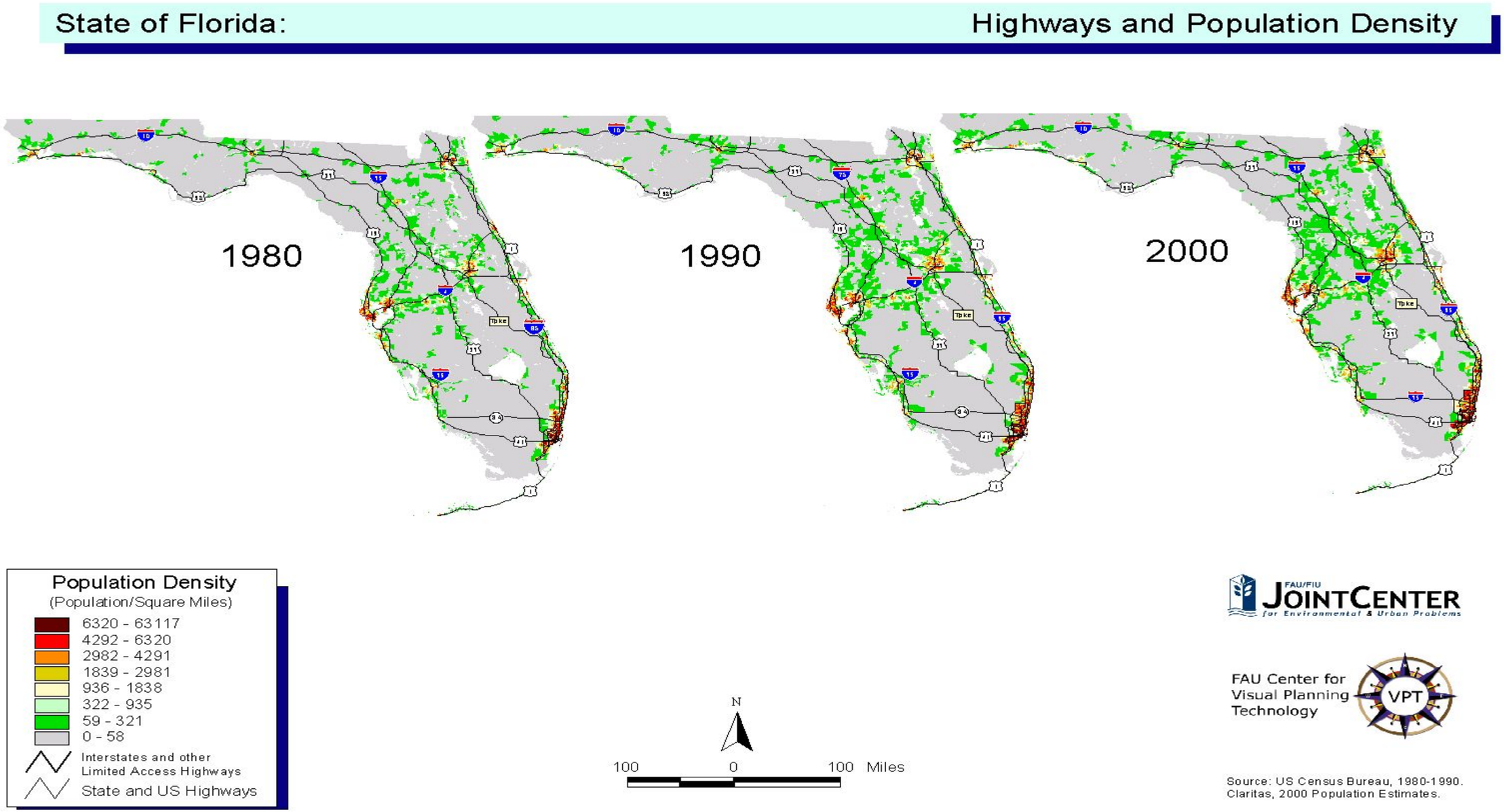
In 2000, Florida still remained the fourth most populous state in the nation. The state now has close to 16 million people, up 23.5 percent from 1990, ranking it third in population increase between 1990 and 2000. Florida's sprawling development patterns

places 296.4 persons per square mile throughout the state.[46] The state's highest densities can be found in coastal counties, where the average density is 430.4 people per square mile in comparison to 129.6 persons per square mile in non-coastal counties.[47]

Much of Florida is still lightly populated. In some places, mainly northern Florida, the densities are as low as rural areas of Montana or Wyoming.[48] The state's development and urban growth patterns have varied from a north versus south perspective. Warmer temperatures, deep water ports, international airports, and other amenities in the southern half of the state may have attracted more population and more development, while lack of the above have kept the panhandle and most of the northern section of the state less developed and more sparsely populated, in spite of the proximity to neighboring states.

The degree of density and intensity of development in certain places of Florida is apparently a result of the combination of several factors, such as geography (particularly beachfront), policies, demographics, economy (mainly tourism), and infrastructure investment. In particular, highways and automobiles seem to have had an interesting effect on development throughout the state. Settlement patterns in the state indicate that urban growth and intensity of development has been highest in coastal areas with highway access, with the exception of Orlando, where manmade amenities may have played a larger role than accessibility to the beach. Highways have also expanded development away from the coast. In some instances, highway interchanges show the highest rate of recent development. In the south, intense linear development can be found along transportation corridors expanding west where many cities are growing on the urban fringes of larger ones.

Figure 2: Changes in Highways and Population Density by Census Block, 1980, 1990, and 2000



In central parts of the state, as shown in Figure 2, between 1980 and 2000, new residential and industrial developments are springing up near highway corridors and interchanges where transportation accessibility is highest. This is most evident in the central areas surrounding I-4 and I-75.

Densities in coastal counties are increasing at a faster rate than in non-coastal counties (Figure 3). Whereas densities in non-coastal counties have changed very little, densities in coastal areas have quadrupled in a fifty-year period. The non-coastal counties have changed very little density-wise, which means development is consuming greater amounts of rural land.

Figure 3: Change in Florida's Density Between 1950 and 2000

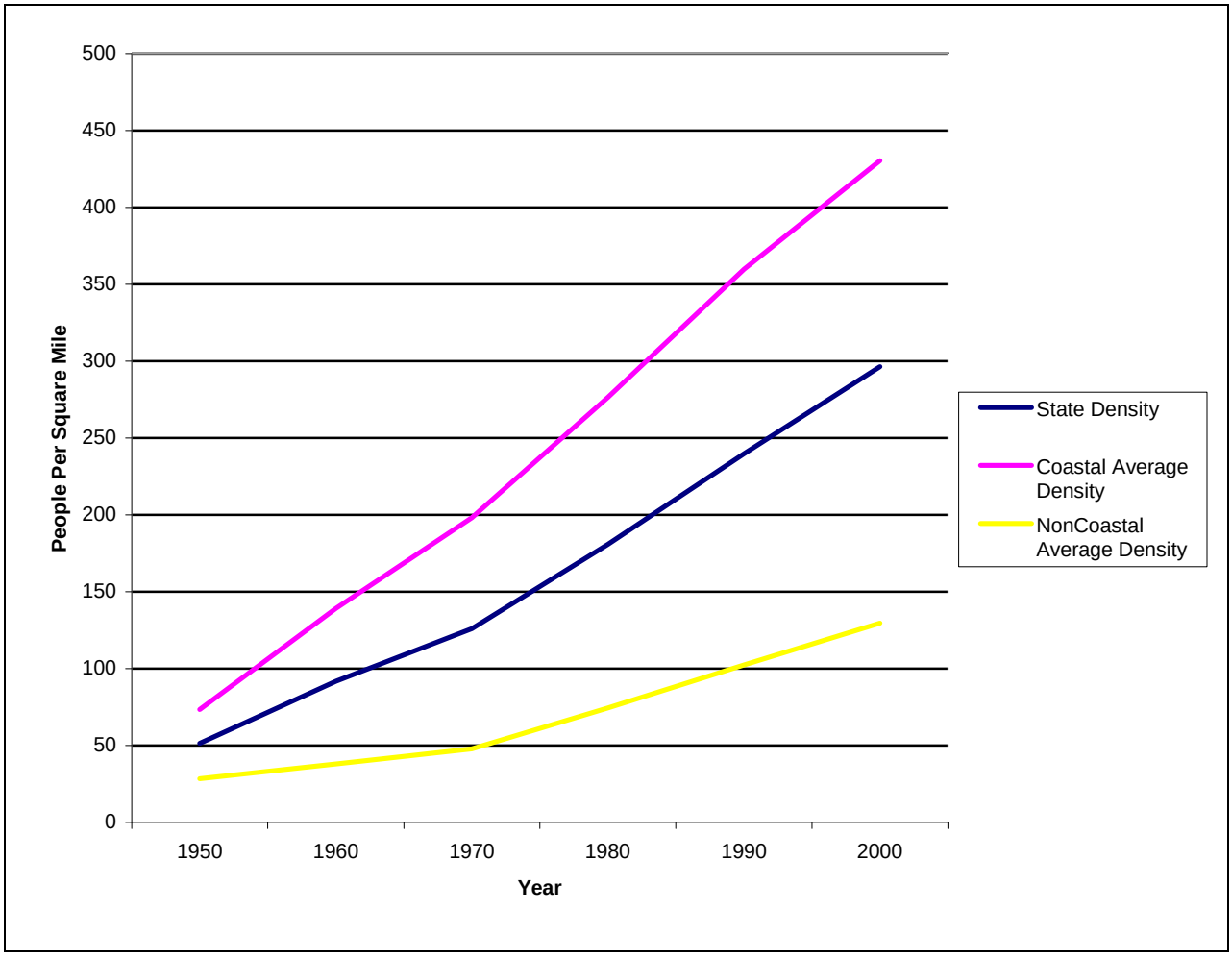
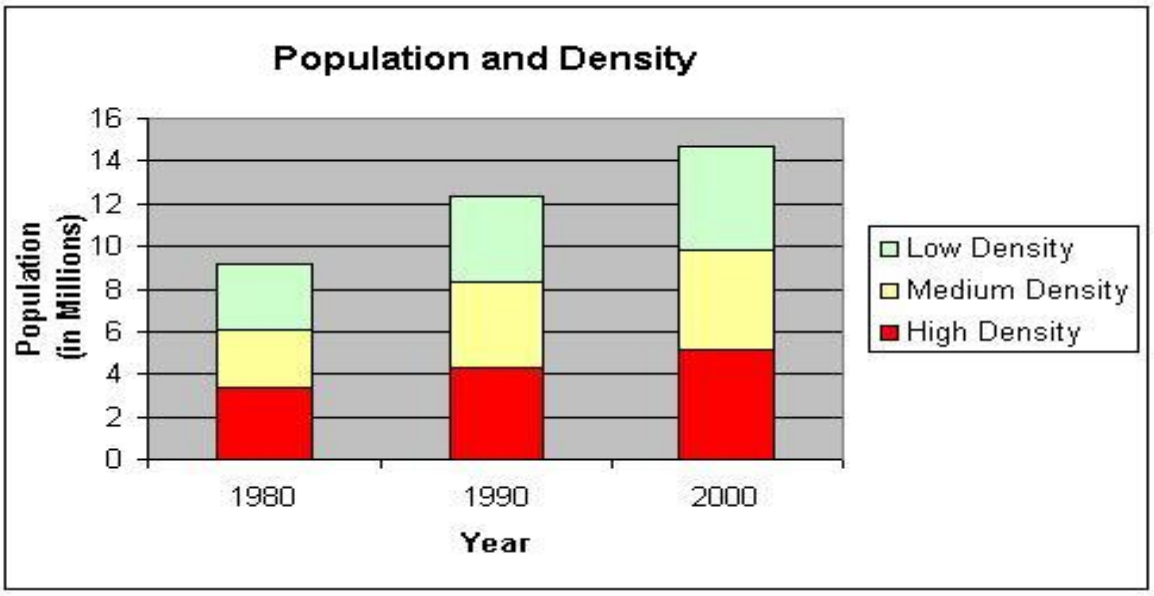


Figure 4: Population Growth by Density Category, 1980, 1990, and 2000[1]



Source: U.S. Census Bureau 1980-1990 Claritas 2000 Population Estimates

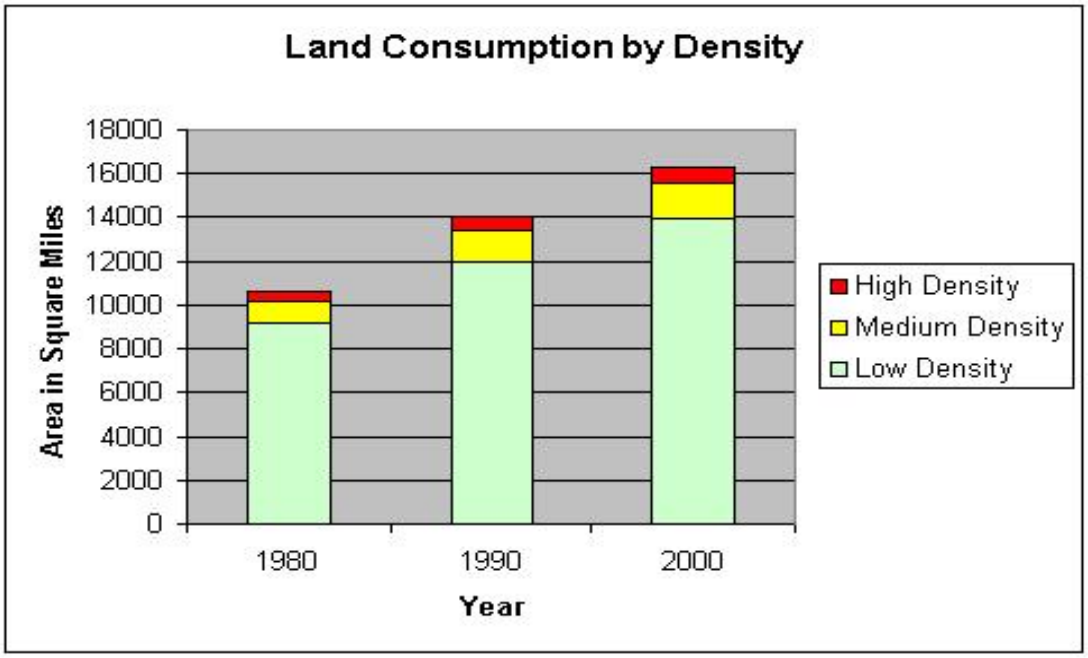
Job opportunities, recreational attractions, including the beaches, and higher levels of services, particularly education, continue to attract new residents to the metropolitan areas, pushing growth to higher densities where vacant land is more valuable or to the urban edges, where land is cheaper and more abundant. Densities in general have risen, but land is being consumed at a faster rate than before. In spite of the increase in densities, the amount of all types of land consumed has steadily increased (Figure 5).[49]

Figure 5 illustrates how low density urban development in Florida is consuming land faster than any other density category. In fact, high-density development, as a percentage of total land developed has remained fairly unchanged over the twenty-year period depicted. By comparing the population growth by density category (Figure 4) to land consumption by density category

[1] **Population/Square Mile-**
Low Density: 59-1838
Medium Density: 1839-4291
High Density: 4292-63117

(Figure 5), it becomes clear that the population is consuming greater amount of land at lower densities than at higher densities. This means that urban sprawl is growing at a faster rate than any form of compact development.

Figure 5: Changes in Land Consumption, 1980, 1990, and 2000[2]



Source: U.S. Census Bureau 1980-1990 Claritas 2000 Population Estimates

Sprawl, a term used to describe low intensity, spread out urban development, consumes land and increases the cost of providing services at a faster rate than more compact forms of development.[50] Large-lot neighborhoods and poorly connected roadway networks separate homes from work, schools, and stores by distances that require residents to use their cars. Utility and roadway corridors are longer and thus more expensive to provide. In some cases sprawl development is initiated by the location of a regional mall or industrial complex along a major highway or at a highway interchange, followed by suburban development. Often, however, incipient exurban residential

[2] **Population/Square Mile-**
High Density: 4292-63117
Medium Density: 1839-4291
Low Density: 59-1838

development precedes other types of urban land uses. Much of the leapfrog development that has taken place within the state has occurred because cheaper land can be found away from the urban areas where better road infrastructure meets the state's concurrency standards.

The concurrency requirements enacted by the 1985 Growth Management Act have been an instrumental factor in the state's settlement patterns. It requires transportation and other services to be provided concurrent with new development. It also requires standards of levels of service to be met before additional development is allowed, making it easier to build where the service levels are high relative to existing development. However, zoning laws, which favor low-density development, have also been a critical factor in settlement patterns in the state. Land consumption for urbanization has increased mainly because the intensity of land use is so low. Zoning, which determines density and intensity of development has been biased toward single-family homes, singular land uses, and low intensity development thus promoting a higher consumption of land.

Regional Issues and Trends

During the heavy growth period between 1960 and 1990, a number of regional distinctions emerged. The rural population in southeast Florida virtually disappeared and the region's character became distinctly urban. By 1980, the areas east of the Everglades dike in Broward and Miami-Dade Counties had become 99 percent urban.[51] Dense development was closer to the coast. However in once rural areas, less dense development began to scatter around the interchanges and access ramps. "The conversion of land from rural to urban uses far outpaced the state's population growth between 1973 and 1984, causing a decline in urban density." [52] With the affordability of cars and the mobility it provided, more people were able to move further away from central cities. People, wanting to achieve the American dream and wanting to escape from the

deteriorating conditions of urban neighborhoods, sought to follow their dreams and the automobile and roads helped them.

South Florida's development is most dense in the coastal counties. As the population increases in coastal areas, more Floridians will begin moving north of Interstate 4.[53] This shift northwards is caused by the increasing land values of coastal land, a direct result of the increase in population.[54] The increased intensity of development in northern and central areas of the state can already be seen. In some instances, development in northern parts of the state is taking place in unincorporated areas. Some county governments are not ready or able to handle the responsibility for providing roads and other infrastructure that accompany increased growth. This encroachment on central and northern counties has caused surrounding lands around large metropolitan areas to become more urbanized than rural over the years. The highways and major roads, mainly in place to transport goods, have been inviting new development and people.

In central Florida, small towns surrounding citrus and farm communities are changing their character rapidly. In the '90's it was predicted that by 2000, much of nonurban central Florida would be a part of a large metropolitan area.[55] The prediction seems to be right. Central Florida has become an attractive place for development with three major interstates, two international airports and port systems on both the Atlantic Ocean and the Gulf of Mexico. The Lake Mary/Heathrow corridor along I-4, north of downtown Orlando is currently establishing a reputation as a new business center.[56] It is expected that area will get more and more dense as development continues.

Another factor that will increase density around the state is the desire for new in-migrants to want a balance in their own lives. Individuals want to live in the nice climate and have access to good-paying job opportunities and good, yet affordable, quality of life for themselves and their families. Cities like Jacksonville, Tampa, and Orlando with the attraction of new regional and corporate offices and

high-tech firms are positioning themselves for the population growth that will stem from desire for balance.

Intensity and density of development are driven by policy and market demand and access to lands. Individuals are going to relocate where social, and economic opportunities are. As central cities, such as Miami, Ft. Lauderdale, Orlando, Tampa and Jacksonville, and West Palm Beach try to maintain their competitive edge, more will begin to revise land use policies and explore alternative modes of transportation that will create greater density and make providing public services more efficient. The trend to changing intensity and density of land uses is being pushed in certain municipalities; not all. However, it seems there will be more effort to consider the impact of local decisions from a regional perspective as the problems in the southeast begin to threaten other areas of the state.

Future Challenges and Trends

While other states are struggling to promote population and economic growth, Florida is expected to continue to grow at an elevated pace. An estimated 15 million more people are expected to move into the state by 2020. With southeastern portions of Florida facing build out, urban growth pressures are going to continue to increase in other parts of the state. Businesses and individuals are already beginning to explore the northern and central sections of the state for new development opportunities and resources where land is cheaper, yet highly accessible.

Expanding companies often move because they are unable to find more space in their current locations and must look elsewhere for affordable land. Decisions to change location, however, are sometimes prompted by a general decline in the quality of life. Companies competing for skilled labor look for communities where the quality of life is generally high and avoid places where overburdened services and congested roadways have become a deterrent.

Mobility and traffic congestion are going to remain dominating issues facing the state in the 21st century. The ability to move people and goods in a timely manner will be first and foremost on many planning agendas. Transportation in the past has been more of a state and federal enterprise. However, in 1990 the FDOT handed over parts of the urban highway system to local governments.[57] This has increased the challenge of coordinating planning with other governmental entities to continue ensuring mobility around the state. With the current road network under a strain for transportation funding, there is an immediate need for better-land use planning among local governments and a need for providing alternate modes of transportation. By 2020, the number of miles traveled on public roads in Florida is expected to rise by 58 percent, if current trends continue. But the state will have neither the money nor the land to build enough highways to accommodate that growth, according to the Department of Transportation's 2020 Plan. So congestion is expected to continue to increase.

Whereas transportation spending in past years has supported sprawl-inducing highways and automobile-dependent land use, policy-makers are now seeing transportation programs as opportunities to reverse old policies and support the revitalization of long-neglected infrastructure, maintenance, transit, walking, and bicycling. Much of this has been influenced by the funding structure created through ISTEA and TEA-21 (see Policy Chapter). Trends are also focused on placing advanced transportation infrastructure that will connect sub regions of the state to create an overall regional structure, which will require coordination and collaboration between local, regional, and state, as well as Federal agencies.

Other elements will affect trends in urban growth. With the state making an effort to change old trends in transportation planning, there seems to be more movement toward critical land use and policy changes around the state. A few metropolitan areas are turning to delineating urban development boundaries (UDBs) to manage growth. While this policy will control exurban development

within the counties that establish UDBs, it will not affect neighboring counties lacking in such controls. Also UDBs do not necessarily stop sprawl if the development permitted on excess land within the boundary is sprawling in nature.

An added benefit to growth boundaries is that infill and redevelopment opportunities will become more attractive to developers as greenfields vanish. Policy initiatives such as revitalizing the Eastward Ho! Corridor in southeast Florida and promoting mixed-use development are expected to grow in demand. This type of strategy will also focus on alternative modes of transportation and redesigning communities to minimize auto dependency. Trends will see continued development of coastal counties, especially beachfront property. New high-rise hotels and condominiums are still being developed along the coast and this will continue as long as their room for them.

Other issues, which may eventually have an impact on growth and development around the state, include quality of life factors. High-tech companies seek to provide the highest quality amenities for their employees including recreational opportunities, but much more importantly, educational opportunities for their families and themselves. Higher level learning centers such as universities are now partnering with their communities to provide educational opportunities, and they are also partnering with private industry thus creating a symbiotic relationship where the university provides an educated workforce while the business provides funding for research and infrastructure. This combination helps to attract other related industries to the area. Communities, local businesses, and universities are partnering to foster a climate that will attract more businesses to the area through policies and initiatives, such as the I-4 Florida High Tech Initiative corridor and the Internet Coast along I-95 in south Florida.

Other quality of life issues to be monitored include cost of living factors. As cheap land becomes scarce in some areas of high demand, housing will become

more expensive. Increasing densities helps to offset development costs and provides opportunities for mass transit, offsetting the cost of car ownership. However, many "infill" projects near desirable locations also tend to have higher market values. Increasing demand for limited resources will also create a cost increase. Recently, a major drought and increasing demand for electricity have brought to the forefront the potential for crisis in the provision of these services. A change in any one of these factors will affect cost of living, more so a combination of any of the above.

Finally, Florida is subject to major hurricanes. Each time a hurricane hits an urban area, insurance rates around the state rise. This has already had an influence on the affordability of coastal neighborhoods. It may eventually have a greater influence on living anywhere in Florida, particularly in areas prone to flooding.

Conclusion

Florida's growth and development patterns are clearly related to the construction of transportation infrastructure throughout the state. The state's most intensive growth period, between 1960 and 1990, coincides with the development of Florida's Limited Access Highway network, funded by the 1956 Federal-Aid Highway Act. The necklace of development in Florida is strung along the coast and major highways. Where east/west connecting highways have originated, pockets of urban development have formed as well. Florida's highway network not only increased the movement of goods but it encouraged the mobility of people, socially and physically.

Water, as an amenity and resource, has been a major factor in the development of the land use/transportation relationship in Florida. Although the state is no longer dependent on water as the primary mode of transportation, water has continued to help attract development and growth and support the economy in all regions of the state. Coastal counties have had a successful

tourism industry due to their close proximity to the ocean while rural agricultural counties have benefited from their close proximity to lakes, rivers, and other water bodies.

A state once deemed as uninhabitable swampland has transformed into a region of several urban centers connected by highways. In the past urban growth has been highest in coastal areas because of its accessibility to the state's highway system, proximity to waterfront, policies that contained growth within the boundaries, and physical limitations. Today, as more roads are constructed or expanded and stringent growth management policies remain in place, the relationship between land use and transportation becomes more distinct. Growth management policies have made it feasible and convenient for new growth to move toward predominantly rural areas closer to highway interchanges and access ramps. As a result, over 150,000 acres of Florida land are converted each year.

Although coastal areas continue to have a higher population and density than rural areas, urban growth is no longer confined to the coast. Growth is continuing to move to rural counties where the land is cheap and growth management policies are less stringent. Development has managed to sprawl outward from the core of urban centers and is now beginning to encroach upon agricultural and protected areas. With economic generators such as universities, major tourist attractions and the government attracting transportation infrastructure and development, it would seem that the major limiting factors to future urban growth within the state would include protected areas, water supply limitations, and the lack of a commitment to alternative modes of transportation.

Appendix

Methodology

Changes in Highways and Population Density by Census Block, 1980,1990, 2000:

The data set used in the GIS portion of the project was provided by Claritas copyright 2000, which included US Census Data for the 1980 and 1990 Censuses as well as a 2000 forecast as provided by Claritas. The data was provided in Tract and Block Group form. For the creation of the mapping data, Block Group data was used because it provided the highest level of detail at the smallest geographic level available.

The map, Total Population Florida, illustrates population growth in Florida with the Census Block Data distributed into 8 categories, to illustrate less extreme variation of the data. The Natural Break format was used to analyze the data, which aggregates data by finding groups and patterns inherent in the data set. To establish a uniform legend, the data was sorted for each year to determine which population field had the highest range of data. This was necessary to capture all records. The year 2000 had the highest range of data, and the legend was created based on this field. The created legend was then applied to the datasets for 1980 and 1990 for consistency, and the results were drawn.

For the density maps, fields were created in the database for density in any given census block by decade year 1980, 1990, and 2000. The data was calculated by dividing the population of that census block for each year, by the area of that census block, a field was created for 1980, 1990, and 2000 population density results. To establish a uniform legend, the data was sorted for each year to determine which density field has the highest range of data, which was necessary in order to capture all records. Surprisingly, 1980 had the highest

density range. The data was then sorted into 8 categories using the quantile distribution method. In the quantile classification method, each class contains the same number of features or records. Once the quantile legend was created, it was then applied to the datasets for 1990 and 2000, and the results were drawn.

Land Consumption by Density Bar Chart:

The bar chart is based on the results of the legend created for the density maps. The range of observations for each quantile was applied to the Total Population, and Area fields of the Census Database. The data that fell in each quantile was then summed for 1980, 1990 and 2000 fields, and the results were presented in chart form.

The software used in this process was ArcView GIS 3.2, Access and Excel 2000. The maps are in Geographic format (latitude and longitude).

Change in Florida's Density Between 1950 and 2000:

The data for the years 1950-1990 were obtained from BEBR's 2000 Florida Statistical Abstract and the data for the year 2000 was obtained from the United States Census Bureau at www.census.gov. The Change in Florida's Density chart was created by first dividing the counties into two categories: coastal and non-coastal. Coastal counties were determined to be counties directly along the east and west ocean coast of the state. The remaining was grouped as non-coastal. The counties were placed in a blank spreadsheet and the population totals for the years 1950, 1960, 1970,1980, 1990, and 2000 were inputted under either the coastal or non-coastal category. The total population for the coastal counties and non-coastal counties were then added.

The land area (not including water bodies) for each county was added to the spreadsheet. The total land area was then added for both the coastal and non-coastal categories. This allowed the density calculations to be performed for

each county individually and aggregately for the ten-year intervals whereas the population divided by land area derived the density.

The same procedure was followed for the state data. The total population of the state (not including water bodies) was divided by the total land area for the state. The density numbers for the coastal group and non-coastal group were then plotted next to the state's average density.

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Florida Trends and Conditions

2000 – 2001




Trends in Transportation and Air Quality

Prepared for:
Florida Department of Transportation

Prepared by:

FAU/FIU JOINT CENTER for Environmental & Urban Problems

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Florida Trends and Conditions 2000- 2001

Trends in Transportation and Air Quality

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Executive Summary

This report is part of the Florida Department of Transportation's *Trends and Conditions Project* and investigates the relationship between transportation and trends in the emission of Nitrogen Oxides, Carbon Monoxide and Hydrocarbons in Florida. The results are based on trends in average emission rates for each of four vehicle types (heavy duty trucks, light duty trucks, passenger cars and motorcycles), trends in Vehicle Miles Traveled (VMT) by vehicle type and trends in vehicle composition. The report shows that improvements in vehicle emission rates have largely been offset by increases in VMT and changes in vehicle composition. It also shows that areas in Florida with high population growth, such as the Naples-Fort Myers area, Tampa-St. Petersburg, Orlando, Jacksonville, and southeast Florida, are likely to experience increased emissions of air pollutants from transportation in the next ten years. This increase will be most profound for Nitrogen Oxides since the average reduction in emission rates for this pollutant is much lower than for other pollutants.

Air Quality Trends

The most profound environmental effects of transportation are on air quality, especially the ambient concentration of Carbon Monoxide (CO), Nitrogen Oxides (NO_x), Volatile Organic Compounds (VOCs), Ozone (O_3) and Carbon Dioxide (CO_2). Table 1 shows that the U.S. Environmental Protection Agency estimates that transportation is responsible for 93 percent of all CO emissions, 52 percent of all NO_x emissions, 90 percent of all VOC emissions and 30 percent of all CO_2 emissions. It is difficult to determine the exact contribution to ambient O_3 concentrations since O_3 is a so-called secondary air pollutant and is not directly emitted but formed by chemical reactions between VOCs and NO_x in the atmosphere. Since transportation is both a source of NO_x and VOC, over 90 percent of ground level O_3 in urban areas is probably directly or indirectly attributable to transportation.

Table 1: Direct Contribution of Transportation to Air Pollution

Pollutant	Total Transportation Contribution	Relative Contribution
CO	60,794 Gg[1) 3)]	93 % [(3)]
CO_2	446.5 MMTCE[2)]	30% [(3)]
NO_x	10,519 Gg	52 % [(3)]
VOCs (Non methane)	6,949 Gg	90 % [(3)]
MTBE	no data available	
SO_2	1,252 Gg	15 % [(3)]
Particulate Matter	no data available	
N_2O	17.5 MMTCE	16 % [(3)]
HFCs	4.5 MMTCE	12 % [(3)]

1) Giga Grams = 1 kiloton
2) Metric Mega Ton Carbon Equivalent
3) From U.S. EPA Inventory of greenhouse gas emissions and sinks, 1999

For transportation, the air pollutants of main concern in urban areas are CO, NO_2, O_3, VOCs and Particulate Matter (PM). All these pollutants can have a direct effect on human health and are regulated under the Clean Air Act. SO_2 is also regulated under the Clean Air Act but transportation is a relatively minor source for this pollutant.

Carbon Monoxide

Carbon monoxide (CO) is an odorless and colorless gas produced by incomplete combustion of fuel and is produced when fuels are burned under less than optimal conditions. Since the control of combustion processes in stationary sources is typically much tighter than for mobile sources, mobile sources account for most of the CO emissions. CO interferes with the hemoglobin's ability to absorb oxygen from the air and reduces the ability of blood to deliver oxygen to vital tissues in humans. It can also impair vision, cause dizziness, and ultimately lead to unconsciousness and even death.

Nationwide emissions of CO have declined since 1970, and since 1989 there has also been a 22 % decline in CO emissions in Florida.[1] Still, CO concentrations in urban areas remain high, with a typical range from 5 to 50 parts per million (ppm), while congested highways can range up to 100 ppm.[2] Although the one-hour ambient air standard for CO is 35 ppm, negative effects on human health have been reported at this level. Therefore, the federal standard has been criticized as not being strict enough and California's air quality standard has been set at 20 ppm.[3] Hourly concentrations of CO usually reflect citydriving patterns, with peaks occurring during morning and afternoon rush hours on weekdays and a peak in the late afternoon during the weekends.

Ozone

Ozone (O_3) is a severe irritant and causes damage to lung tissues, aggravates respiratory diseases and makes people more susceptible to respiratory infections.[4] It can also inhibit plant growth, especially if elevated levels of sulfur dioxide are also present. O_3 is a secondary pollutant, meaning that it is not directly emitted into the air. Instead, O_3 is formed by a set of reactions between hydrocarbons and nitrogen oxides under the influence of sunlight. These reactions form a number of so-called photochemical oxidants of which O_3 is the most abundant. Since the formation of O_3 is dependent not only on the presence of chemicals but also on the intensity of sunlight, in most of the United States, O_3 is predominately a problem in the summer. However, in central and southern Florida, problems with O_3 occur from early spring to summer. The

intensity of sunlight is not high enough to cause problems in the winter, but during the spring light intensity is already high enough to lead to the formation of O_3. Because of afternoon thunderstorms and overcast skies, O_3 becomes less of a problem during the later part of the summer in these areas.

High concentrations of O_3 prompted the Environmental Protection Agency (EPA) to declare six counties in Florida (Broward, Dade, Duval, Hillsborough, Palm Beach and Pinellas) as *ozone nonattainment areas* in 1987. Under this designation, the State of Florida faced possible federal sanctions in the form of withheld highway construction funds and the potential of a moratorium on the construction of new industrial facilities. The Florida legislature responded to this designation by enacting the Clean Outdoor Air Law (COAL) which authorized the Motor Vehicle Inspection Program (MVIP).[5] In 1991, the emissions testing programs were implemented in the six counties. MVIP established mandatory annual emission inspections of passenger cars and light duty trucks, model years 1975 and later, weighing 10,000 pounds or less, which were registered or primarily kept in any of the six counties[6]. Under MVIP, vehicles that failed the inspection had to be serviced and could then be retested. Vehicles that continued to fail the testing program were ultimately taken off the road. When MVIP started, failure rates were approximately 10 percent, after five years the failure rate had dropped to around 5 percent. According to the 1996 MVIP annual report, failure rates probably dropped because vehicles were better maintained and gross polluting vehicles were taken out of service because of too costly repairs.[7] Estimates of the positive effects of the MVIP indicate that the program reduced hydrocarbon emissions by approximately 12 percent or 50 tons per day and CO emissions by 17 percent or 628 tons per day during 1995.[8] The EPA redesignated all six counties as *air quality maintenance areas* during 1995-1996. After considerable debate, the state legislature decided to eliminate the MVIP in July 2000.

Although there are currently no ozone nonattainment areas in the State, O_3 remains a problem in Florida. For instance, according to the Florida Department of Environmental Protection (FDEP), Escambia County violated the eight-hour O_3 standard

on March 29, 1999 and Hillsborough County violated the standard on May 15, 1999.[9] These violations could result in designations as ozone nonattainment areas for these two counties. Furthermore, Broward, Dade, Duval, Palm Beach and Pinellas are designated as maintenance areas and still face the possible threat of sanctions under the Clean Air Act.

Nitrogen Oxides

The direct health effects of nitrogen oxides (NO_x) are still uncertain but as mentioned above NO_x plays an important role in the formation of ground-level O_3. Prolonged exposure to NO_x has been linked to increased bronchitis in children.[10] NO_x also reacts in the atmosphere to create Nitric Acid which is an important component of acid deposition.

According to the 1996 MVIP annual report, NO_x is the most serious air pollution problem for Florida in the future.[11] The Clean Air Act requires that ambient NO_x concentrations do not exceed 1990 levels, or an area might be designated as a NO_x nonattainment area. The consequences of such a designation are similar to those with the designation as an ozone nonattainment area and include the withholding of highway construction funds. FDEP has also indicated, in its quarterly reports, that NO_x is the air pollutant of greatest concern for Florida. However, in its December Quarterly Report, FDEP notes that NO_x emission dropped slightly in 1997. According to the report, air quality monitors measured annual averages for NO_x ranging from 18-30 micrograms per cubic meter, which is considerably under the national standard of 100 micrograms per cubic meter.[12] According to FDEP, NO_x has not been a threat to human health in Florida due to its relatively low concentration. The primary concern stems from its role as a precursor to ground level O_3.

Trends in the Emission of Air Pollutants from Transportation

In recent years, emission rates from vehicles have been decreasing. However, the reduction in emission rates has been largely offset by increases in vehicle miles

traveled (VMT) and changes in vehicle composition from relatively clean passenger cars to larger personal trucks and Sport Utility Vehicles (SUV's). We will also show that a large part of the reduction in emission rates is caused by improvements in heavy-duty vehicles, while the emission reductions for passenger cars have been relatively small.

It is not the purpose of this section to predict Florida's air quality. Air quality trends are influenced by many unknown and extremely difficult-to-determine factors such as wind velocity, wind direction, turbulence, precipitation, hours and intensity of sunshine and surface structures. For that reason the focus of this report will be to analyze vehicle air emissions as indicators of air quality. This section is separated into three main parts:

1. Analysis of the vehicle-related air emissions at the national level.
2. Analysis of the vehicle-related air emissions for Florida.
3. Projections of the vehicle-related air emissions for Florida during the years 1990-2010.

National Level Air Emissions

At the national level, many publications have reported that vehicle-related air emissions are improving. Figure 1 is an example of these trends. Displayed in this figure are three graphs depicting the national average emission rate by vehicle type for each of the following three pollutants: Carbon Monoxide (CO), Hydrocarbons (HC) and Nitrogen Oxides (NO_x)[13].

The individual graphs of Figure 1 show that there has been an overall reduction of 33 % HC, 38 % CO and 31 % NO_x in average emission rates. The most significant improvements have taken place due to reductions in the emission rates of heavy-duty vehicles with a 45 % HC, 50 % CO and 36 % NO_x reduction. These reductions are caused by several factors. First, the EPA issued emission standards for particulate matter (PM) and NOx from heavy duty diesel engines in the late 1980s, which took effect in the early 1990s. Since heavy duty engines are typically kept in use for 6-10

years, including multiple rebuilds, before they are retired/junked, it takes fairly long for the benefits of new heavy duty emission standards to become apparent. (According to the EPA, when EPA issues a new standard for cars, it takes about 4 to 4-1/2 years for half of all cars on the road to be built to those new standards; for heavy duty engines, it takes nearly 9 years before half of all in-use engines are meeting the new requirements)[14]. Second, the reduction is caused by better maintenance of heavy duty vehicles because of increased awareness on the part of heavy duty truck owner/operators and operators of bus fleets[15]. Engines that are properly and regularly tuned up and maintained emit much lower levels of pollution than engines that are "neglected". Heavy duty engines are fairly tolerant of neglect; thus, it had been fairly common for owners of such engines to "cut corners", saving some money in the short term by failing to complete proper and regular maintenance until such time as the need became clearly apparent (by a measurable reduction in fuel economy, for example). However, engine life can be increased considerably (just as is true for car engines) through proper maintenance. With fuel prices rising, even a small fuel economy decrease can be quite costly for vehicles that drive 100,000 miles or more annually.[16] Compared to heavy duty vehicles the reductions in emission rates for light duty trucks are much less significant with a 31% HC, 28 % CO and 18 % NO_x reduction. The reduction in the emission rates for passenger cars is even lower with reductions of 21 % for HC, 20 % for CO and 15 % for NO_x.

Based on the graphs in Figure 1, it could still be concluded that the US is fairly successful in reducing air pollution from transportation. However, as shown in Figure 2, in the same period the average annual VMT by individuals has risen substantially.

Figure 1: 1990-1998 National Average Emission Rates by Vehicle Type, in grams per mile

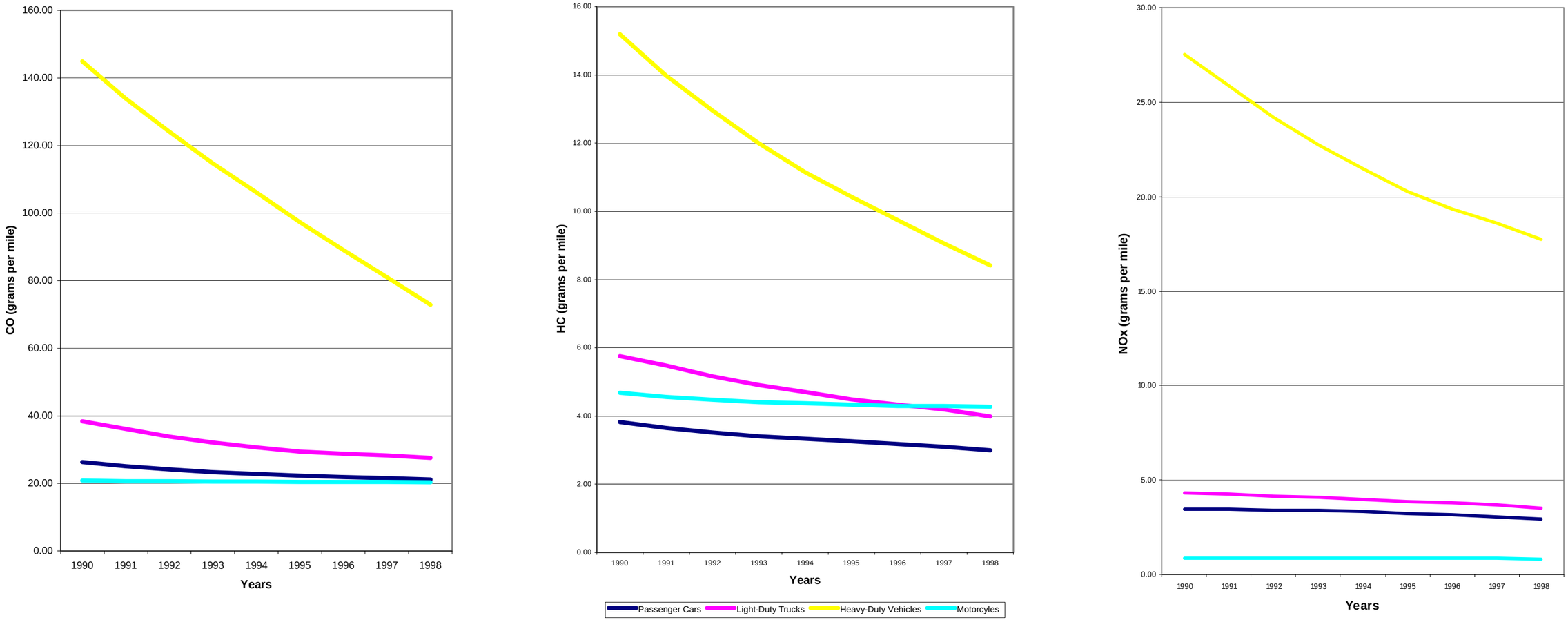


Figure 2: National Vehicle Miles Traveled by Vehicle Type, in grams 10^9 1990-1998

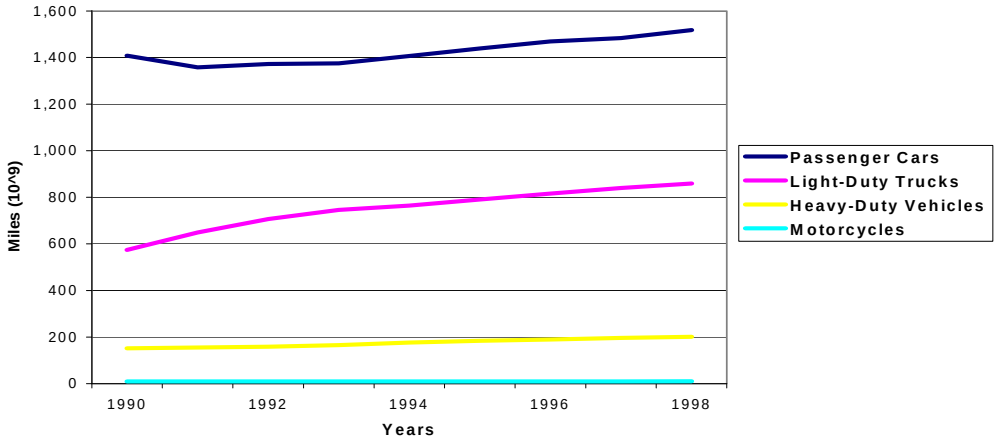
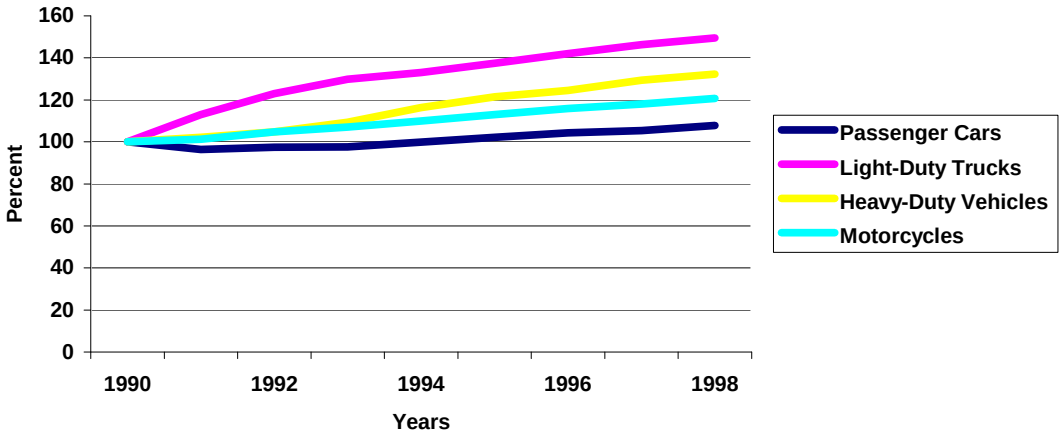


Figure 2 shows, that passenger cars are responsible for most of the VMT, while motorcycles and heavy-duty vehicles together are responsible for barely 10 percent. Figure 3 shows the same information but now uses 1990 as the reference year for each vehicle type. The advantage of this graph is that it shows the relative increase in VMT for each vehicle type. Figure 3 clearly shows that the increase in VMT varies greatly by vehicle type.

The most important trend to notice in Figure 3 is the 50 percent increase in total miles traveled by light-duty trucks during the period 1990-1998. At the same time, the increase in VMT for passenger cars is less than 8 percent. This trend is significant because it shows that there is a substitution from passenger cars to light duty trucks (which includes SUVs). The observation of this trend is consistent with trends in car sales, which show that 50 percent of current car sales are SUVs[17]. It is extremely important to account for this change in vehicle composition when making predictions about air pollution emissions, since light duty trucks and SUVs use more fuel and have considerably higher emissions than regular passenger cars.[18].

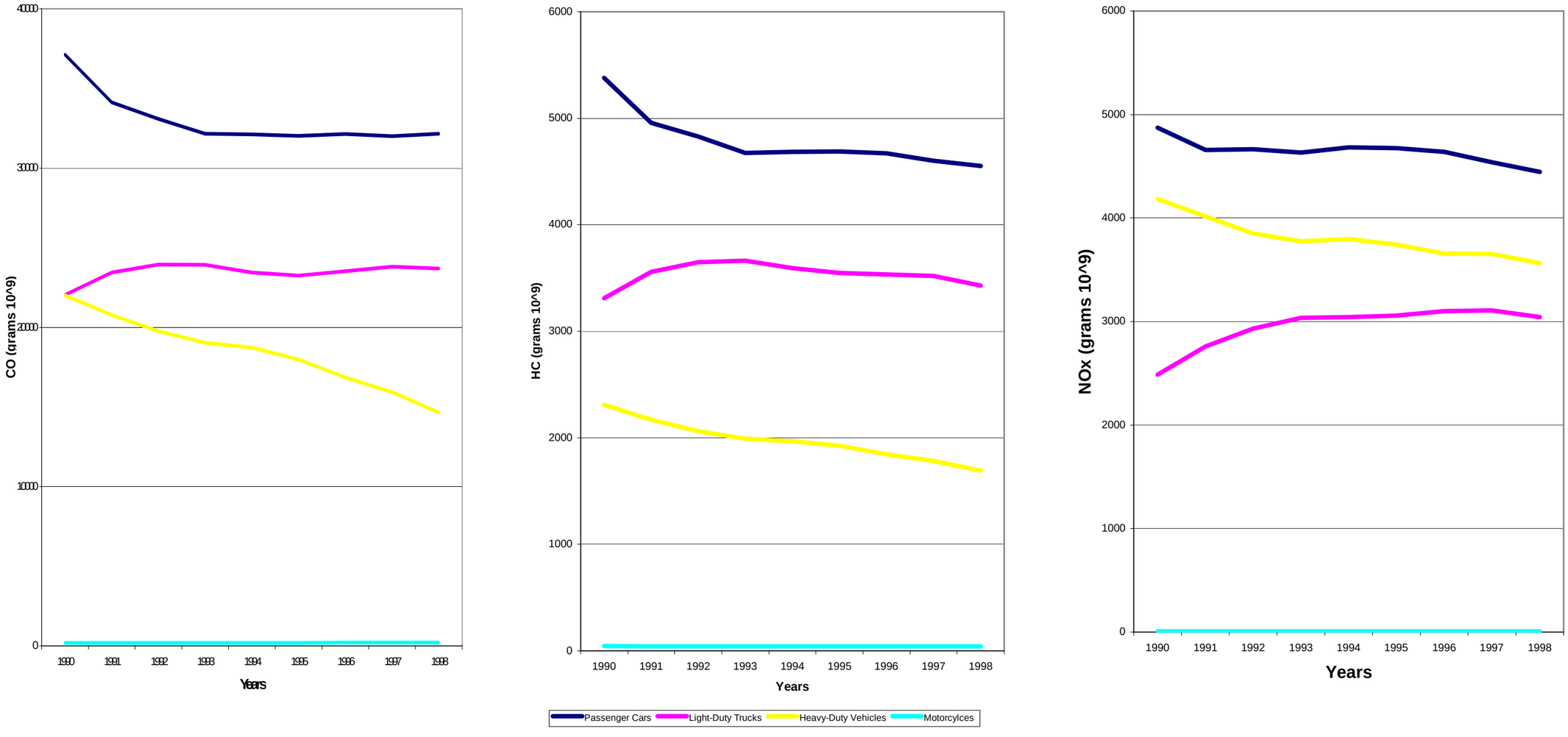
Figure 3: Nationwide Increase in VMT for 1990-1998



The graphs in Figure 4 show the total national emission from each vehicle type. The data for the graphs were calculated by simply multiplying the average annual emissions for each vehicle type from Figure 1 with the total VMT for each vehicle type from Figure 2.

Figure 4 displays an overall trend that total emissions from transportation are decreasing. However the reduction in emissions is much less significant as indicated by the reductions in average emission rates in Figure 1 with total reductions of 12 % for HC, 13 % for CO and 4 % for NO_x. For HC, the reduction came largely from heavy-duty vehicles (27) %. Passenger vehicles also contributed with a 15 % reduction. The total emission for light-duty trucks actually increased by 3 %. For CO, there is a sizable reduction in the emission from heavy-duty vehicles with a total reduction of 34 %. Again, passenger cars also contribute with a reduction of 13 %. Light-duty trucks show an 8.5 % increase in emissions. For NO_x the picture is similar with decreases in emission for heavy-duty vehicles and passenger cars of 15 % and 9 % respectively. In this case light-duty trucks show a very substantial 22 % increase.

Figure 4: 1990-1998 Total National Emissions by Vehicle Type for CO, HC, and NOx, in grams 10^9



Florida

Florida has been experiencing some of the same trends as those seen on the national level. Many publications report that Florida's vehicle-related air emissions are displaying positive results. However, when the data used for these reports is viewed in detail, the reported trends for transportation related emissions again seem misleading.

Since the average emission rates for Florida vehicles were not available at the time of this report, used here were the national average emission rates for passenger cars, light-duty trucks, heavy-duty vehicles, and motorcycles (Figure 4).

Figure 5 depicts the total VMT by vehicle type for Florida during the period of 1990-1998. The trend in Florida is similar to the trend at the national level, with similar increases in VMT for each vehicle type as at the national level.

Figure 5: Florida Vehicle Miles Traveled by Vehicle Type

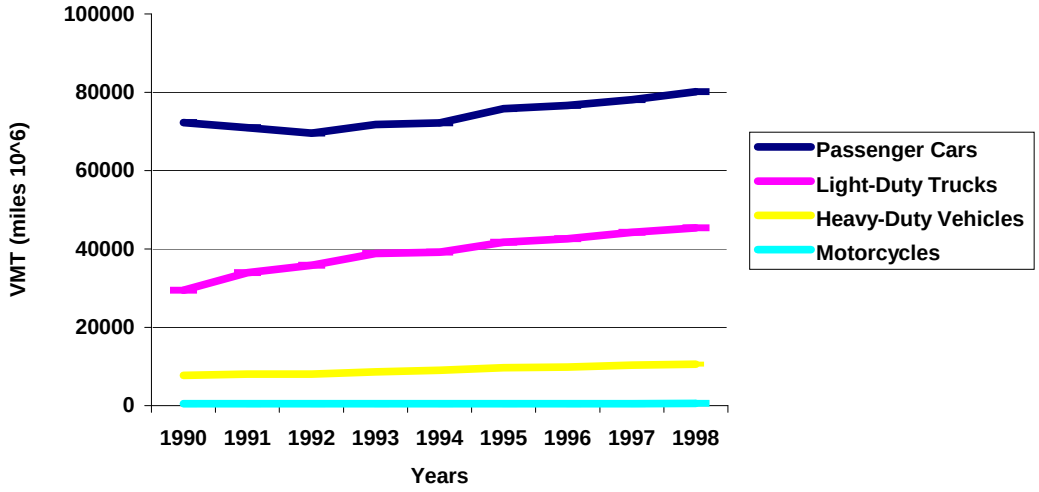


Figure 6 shows the total emissions by vehicle type in grams for the three primary pollutants: CO, HC and NO_x. This was done using the same method as for the national emission by multiplying the national average emission rates with Florida VMT.

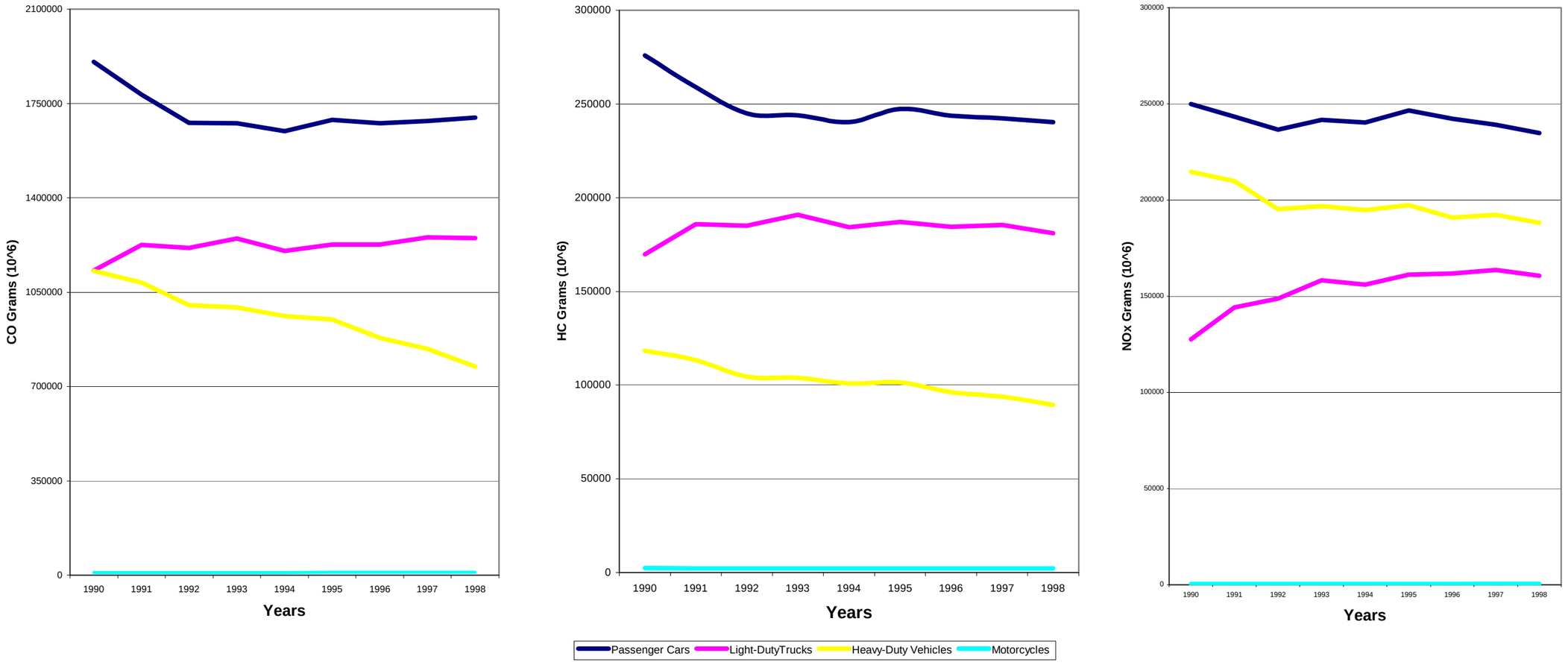
Similar trends to the national level are observed with emission decreases in Florida slightly lower than nationwide decreases, 9% for HC, 11% for CO and 1 % for NO_x. The general trend is also similar to the national trend with an initial decrease in the total vehicle-related air emissions in the early 1990's, and a stabilization towards the mid to late 1990's or increase with time. Most of the decrease in emission can again be attributed to improvements in the average emission rates for heavy-duty vehicles with reductions of 25 % for HC, 31 % for CO and 12 % for NO_x. The total emissions from passenger cars have also decreased with 13 % for HC, 11 % for CO and 6 % for NO_x. However, in Florida, the emissions of light-duty vehicles have increased for all three pollutants, 7 % for HC, 11 % for CO and 26 % for NO_x.

Florida Projections

The trends, forecasts, and predictions for transportation related air emissions are particularly difficult to determine due to the fact that there are many interrelated factors and assumptions involved. The projection of the trends seen above for vehicle related air emissions in Florida has been extremely complex because of the limited data and dynamic conditions presented. The models presented in this report were created using the compiled data at the national and state level.

At the time of this report, linear models were determined to depict future trends for vehicle emissions most accurately, despite producing a few relatively low numbers for coefficients of determination[19]. The logic holds true because even though cubic or polynomial models yielded higher coefficients of determination,

Figure 6: 1990-1998 Total Florida Emissions by Vehicle Type for CO, HC, and NOx, in grams 10^9



their projected results either increased to infinity and or decreased rapidly to zero within several years time. Therefore, the linear models were considered the best available at the time of this report for estimating the general trends for vehicle emission, even though they are considered relatively simple in theory.

The following is a list of assumptions made while developing the linear models used in this report:

- The trends seen for the years 1990-1998 are sufficient enough to produce rough estimates of the future trends.
- The technology advancements during the years 2001-2010 will not dramatically decrease the emission rates of standard vehicles.
- Replacement rates for cars will remain the same as they have been over the past ten years.
- Future policy changes will not change significantly enough to have a dramatic affect on vehicle emissions by 2010.
- The total number of VMT by each individual will continue to increase at the same rate as in the past ten years.
- The national emission data trends are relatively similar to those seen in Florida

Figure 7 displays the Projected Florida Vehicle Miles Traveled for the years of 1990-2010, by vehicle composition, using the stated assumptions. The general trend seen in the graph is a steady increase in total VMT for all vehicle types. Again, because of the lack of data, information related to the maximum road capacities among others, which could theoretically curve and limit the upper bounds of total miles traveled, was not explored. The trend seen is a theoretical amount of VMT.

Figure 7: Projected Florida Vehicle Miles Traveled 2000-2010

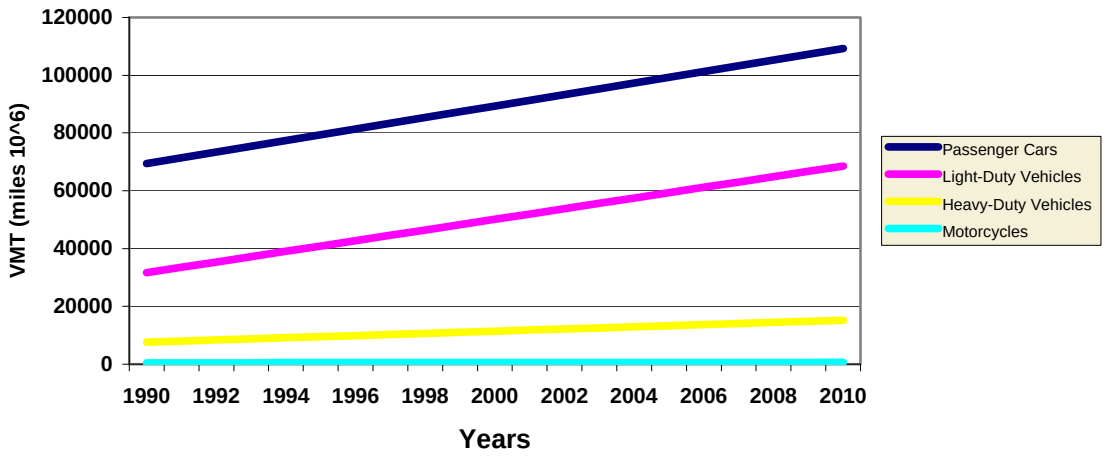


Figure 8 depicts graphs that project CO, HC, and NO_x emission levels for the State of Florida for the years 1990-2010, using vehicle composition and the stated assumptions. In review of Figure 8, it appears that all vehicle types have experienced decreasing amounts of total air emission, except light-duty trucks. The most important and critical findings here is that although technology and regulation standards have made an impact on total emission, the data indicates that people are increasingly substituting cars with light-duty trucks, which include SUVs and the popular four door pickup trucks. As stated earlier in this report, SUVs on average emit more pollutants and are likely to be driven further than standard cars. Light-duty trucks currently account for 40 percent of all total vehicles in use, which is roughly a 25 percent increase over the last decade[20]. Not only has the purchasing trend been for consumers to lean towards light-duty trucks, but demand for larger and more powerful vehicles has also become a major factor in recent years.

Figure 8: 1990-1998 Total Projected Florida Emissions by Vehicle Type for CO, HC, and NOx, in grams 10^9

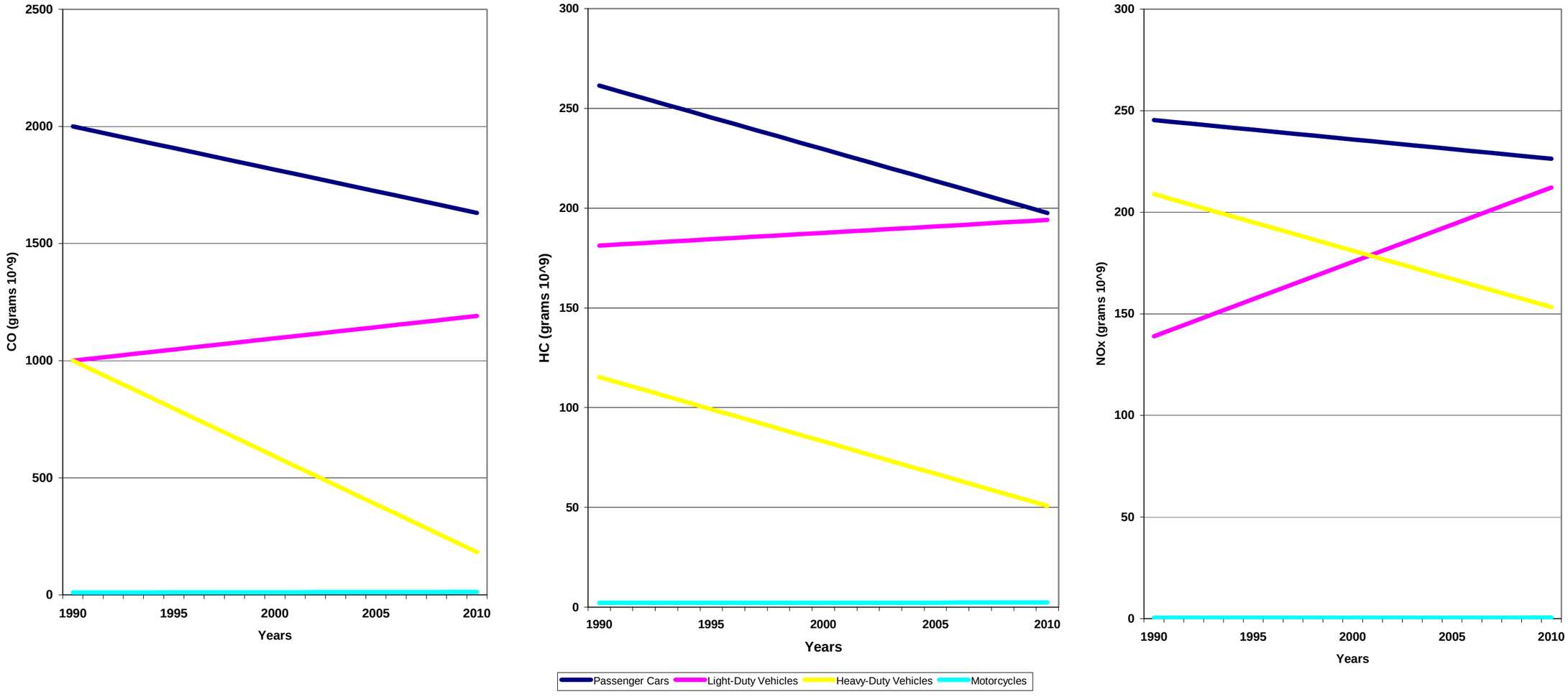


Figure 9: Prediction of CO, HC and NO_x Emissions for Florida

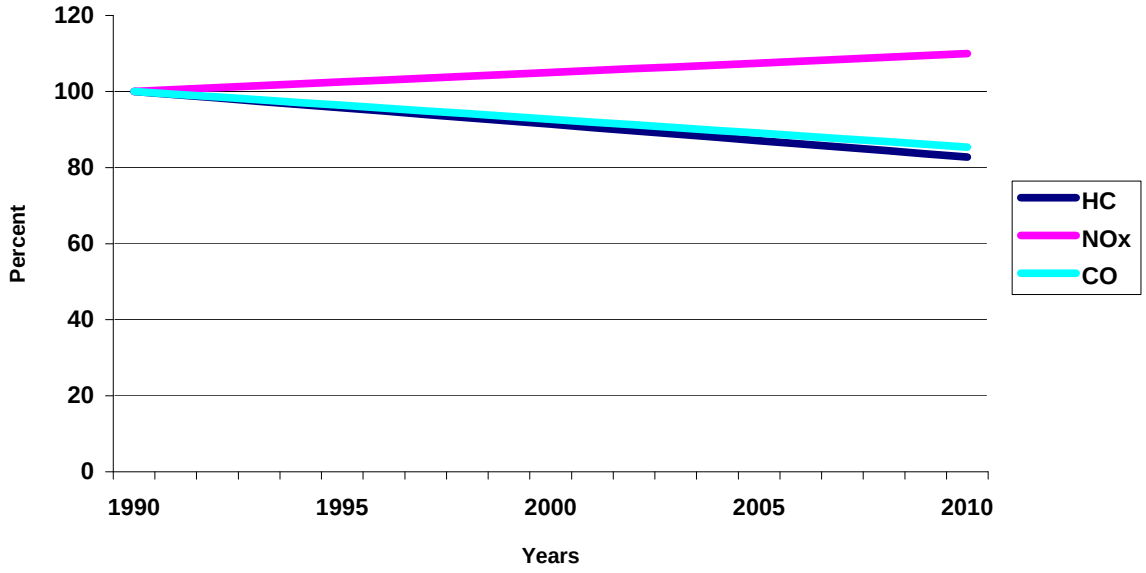
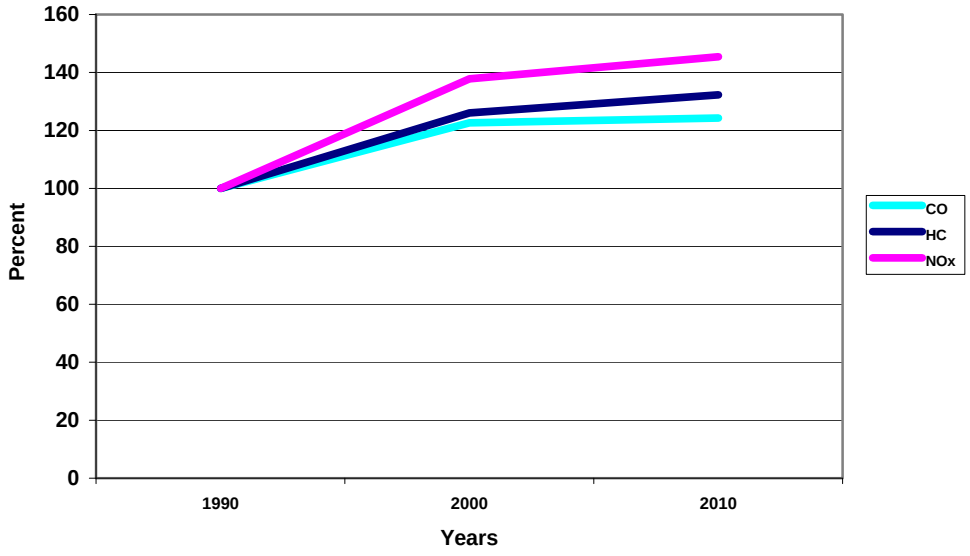


Figure 9 gives a prediction of the total emission of CO, HC and NOx for Florida. In order to easily compare the trends for all three pollutants, the year 1990 was used as the index year. The figure shows that the emissions of CO and HC are decreasing statewide, regardless of increases in VMT and changes in vehicle composition. On the other hand, the emission of NO_x is increasing. Since NO_x is a precursor of ground level ozone it seems likely that problems with ozone will continue to increase. It is likely that these problems will occur in those areas of the state that experience substantial population growth such as the Naples-Fort Meyers area, Tampa-St. Petersburg, Orlando, Jacksonville, and southeast Florida. In areas with high population growth the VMT is increasing much faster than in other areas since these areas are faced not only with increasing mobility per person but also with an increase in population.

Taking the Models One Step Further, Broward County

Figure 9 gives a clear indication of the trends of the emission of air pollutants in Florida. It shows that we can expect increasing problems with ground level ozone based on the increasing emission of NO_x. The figure does not provide information about the location of these problems. Using our method it is possible to perform more detailed predictions for the emission of air pollutants on a county-by-county basis. Using population predictions for each county and combining this with vehicle registration data, future problem areas in Florida can be identified. To show the relevance of such an exercise, Figure 10 shows the preliminary results of such an analysis for Broward County. The figure clearly demonstrates that decreases in emission rates have been completely offset by population growth in Broward County and that the emission of all three pollutants has increased from 1990 to 2000. From 2000 to 2010 our model predicts that both HC and NO_x emissions will continue to increase while the emission of CO will stabilize.

Figure 10: Prediction of CO, HC and NO_x Emissions for Broward County



Conclusion and Discussion

This report has described trends in the emission of air pollutants in the past decade. It has clearly showed that the shift in consumer preferences towards light-duty trucks has caused an increase in the emission of pollutants from these vehicles in Florida. Although a similar shift has occurred at the national level, the effects on the emission of air pollutants is much more profound in Florida. The report has also shown that although there is a general decrease of the emission of pollutants statewide, it is likely that there have been some local increases in high growth areas. Finally, the report has illustrated that a statewide increase is likely in the emissions of NO_x over the next decade. Based on these results, it seems clear that Florida will continue to see some problems with air quality, especially if the trend towards light-duty vehicles continues.

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[19] The model that was used was the first version of an emission model that is being developed at the Department of Urban and Regional Planning at Florida Atlantic University. For information about the specific model that was used for this report, or information about the model in general, please contact, Jaap Vos, Ph.D., Department of Urban and Regional Planning, Florida Atlantic University, 2912 College Avenue, Davie, FL 33314, jvos@fau.edu

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Florida Trends and Conditions

2000 – 2001




Trends in Transportation and Ecosystems

Prepared for:
Florida Department of Transportation

Prepared by:

FAU/FIU JOINT CENTER for Environmental & Urban Problems

June 2001

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Florida Trends and Conditions 2000- 2001

Trends in Transportation and Ecosystems

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Prepared for:
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Joint Center for Environmental and Urban Problems

June 2001

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Executive Summary

Florida supports a diverse and unique combination of ecosystems and has more species than any other state east of the Mississippi. At the same time, 516 species in Florida are listed as endangered or threatened and Florida is home to 4 of the 10 most endangered species in the US. Because of its climate Florida is also extremely vulnerable to exotic species that often out-compete native species and change ecosystems.

The main threat to ecosystems and wildlife in Florida is the loss of natural habitat due to increased urbanization caused by population pressure. It is estimated that 150,000 acres of Florida land are converted to development each year. Habitat fragmentation poses another threat, especially for those species that need large habitats, such as the Florida Panther and the Black Bear.

To offset the rapid transformation of natural habitats to urban development, the State of Florida has been very active in the acquisition of remaining natural areas. At this point in time, 21 percent of all land in Florida (8.38 million acres) is publicly owned preservation land. These lands represent a foundation for the protection of ecologically sensitive and important communities and species.

The first effect of transportation on the natural system occurs during highway construction. Highway construction may cause changes in turbidity, suspended solids concentration, and color of receiving waters. Temporary storage facilities for equipment and supplies used during the construction phase may also damage vegetation and displace communities of animals. Road transportation infrastructure, such as buildings and bridges, also may have habitat impacts. For example, bridges and stream crossings are likely to have significant impacts on hydrology and aquatic habitat.

The most serious effects on ecosystems are caused by roads and the use of the roads. The most evident impacts of roads on wildlife and habitats include:

1. Roadkill.
2. The fragmentation of habitat.
3. Complication of the management of remaining habitat fragments (e.g., fire management).
4. Changes in animal behavior.
5. Provision of habitat and movement corridors for opportunistic species of plants and animals.
6. Disturbance to wildlife.
7. Displacement of plants and animals.

With growing population in Florida, it is likely that conflicts between preservation and transportation will increase. It is also likely that road designs will increasingly have to include components that can mitigate possible negative effects on wildlife. Given the large number of endangered and threatened species in Florida, the Endangered Species Act could have a substantial effect on the construction of new roads or road widenings. The challenge for Florida is to protect its unique natural resources while providing for its growing population. The challenge for transportation is to provide for mobility for Florida's population while preserving the increasingly sparser natural areas.

Ecosystems and Transportation

Florida is blessed with a wide display of unique habitats and wildlife. Unfortunately, both habitats and wildlife are under pressure due to the conversion of natural lands into cities. With continuing population growth in Florida, natural habitats are likely to continue to diminish and preservation of the wildlife habitat that was once abundant will become more and more critical.[1]

The term ecosystem comprises all the relationships between organisms of a given area and their interactions with the physical environment.[2] Living organisms interact with each other in biotic processes and with non-biological organisms in abiotic processes, such as temperature, rainfall, and soil. These interactions are vital to defining which organisms can live in a given area.[3] In Florida, these interactions and other environmental conditions are responsible for the development of distinctive natural communities and plant associations.[4] The State of Florida encompasses a true natural system, not just an ecosystem with geographic boundaries. This natural system not only is important for local ecosystems in Florida but also plays a significant role in the survival of migratory species such as birds and sea turtles, and links Florida's natural system to other systems in the US and the world.[5]

Florida's natural system supports a great diversity of native plants and animal life and has more wildlife species than any other state east of the Mississippi[6]. It is estimated that there are about 3,500 species of vascular plants, 900 species of non-marine vertebrate animals, as well as thousands of species of invertebrate animals. Among the 900 species are 75 mammals, 283 birds, 127 reptiles, 57 amphibians, and 126 fishes. About 115 (17 percent) of these are not found elsewhere in the United States.

Table 1 shows that many plant and animal species are endemic (present distributions occur entirely within the political boundaries of Florida) or nearly endemic ranges extend only slightly beyond Florida's borders. Most endemic species live in the Central Lake Wales Ridge, the Everglades and Florida Keys, and the Apalachicola River area.

Besides the vast amount of endemic species, Florida also serves as an important natural link between North American and the Caribbean Islands and South America. These international linkages include hundreds of bird species and sea turtles that rely on Florida's natural systems to satisfy nesting, wintering and migration requirements.

Table 1: Endemism in Florida's Natural Systems.[7]

	Endemic		Nearly Endemic	
Taxa	**Species**	**Subspecies**	**Species**	**Subspecies**
Vascular Plants	235	NA	40	NA
Freshwater Fish	4	3	4	0
Amphibians	1	5	3	1
Reptiles	6	31	2	4
Birds	0	7	0	2
Mammals	2	56	1	2
Terrestrial and Freshwater Invertebrates	410	0	0	0
Plant Communities	13 (of 70)		NA	

Florida’s ecosystems are truly unique in the world and they are of great importance not only for the beauty and the meaning of life itself but because they support the life of Floridians and they are the key for sustained growth. Some of the characteristics of Florida’s diverse ecosystems are shown in Table 2.

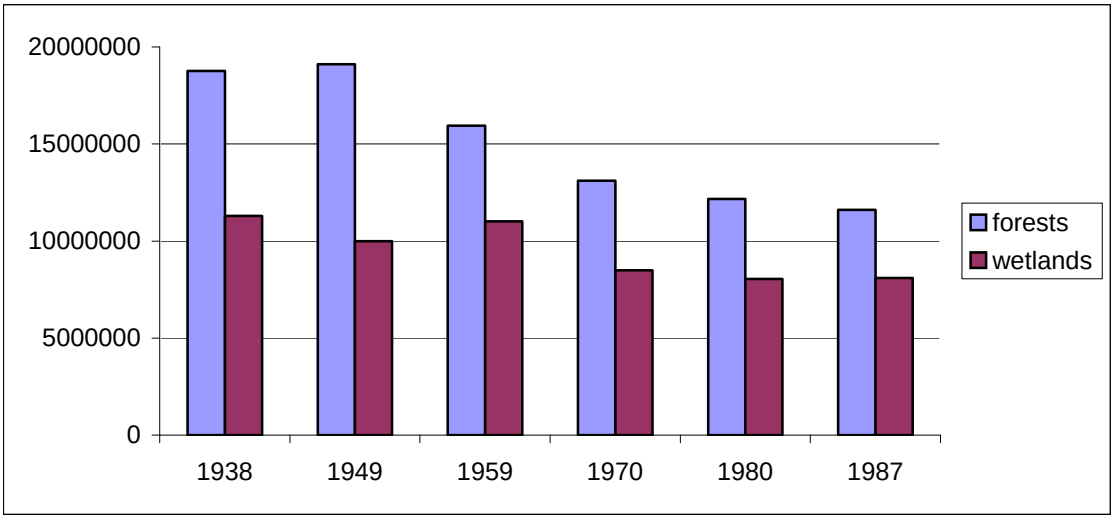
Table 2: Some of Florida's More Unique Historical Features at the Community/Ecosystem Scale.[8]

Natural System Feature	Dimension
Coastline	1,900 km (greater than all other states except Alaska)
Saltmarshes	180,000 ha
Longleaf pine forests	More than 1/5 of the state
Freshwater Wetlands	More than 1/2 of the state
Lakes	7,800 lakes
Rivers	1,700 rivers
Springs	300 springs

Habitat Loss

The main threat to ecosystems and wildlife in Florida is the loss of natural habitat due to increased urbanization caused by population pressure. Nearly 150,000 acres of Florida land are converted to development each year.[9] While less than 2 percent of land was used for urban purposes in 1936, by 1987 more than 12 percent of Florida was devoted to urban land uses. At the same time forests and wetlands showed sharp declines. According to the Strategic Assessment of Florida's Environment, forest showed a 38 percent decline from 1936 to 1987, while wetlands declined with 28 percent in the same time period[10] (See Figure 1). Although, there is no recent data available on the extend of ecosystem loss, it is likely that natural ecosystems have further declined in size because of the continued urban growth in Florida.

Figure 1: Change in Acres of Forests and Wetlands 1936-1987.



In the face of enormous development pressures, lands for wildlife habitat, recreation, greenspace, and surface water protection are increasingly threatened. The Florida Natural Areas Inventory lists 33 of the state's 70 systems, 47%, as globally rare to critically imperiled and 54 (77%) as state rare or critically imperiled.[11] In contrast to most of the other places in the United States, the declines in Florida's natural systems have occurred within this century.[12] A description of changes in Florida's natural systems is shown in Table 3.

The State of Florida has taken a series of initiatives to acquire the most critical resource areas. In the past 20 years, the state has bought over 2.3 million acres of land under the Conservation and Lands Program (CARL), the Save Our Rivers Program (SOR), the Save Our Coast Program (SOC) and the Preservation 2000 Program (P2000) (Table 4).

Table 3: Extent of Temporal Changes in Some of Florida's Communities/Ecosystems.[13]

Community/ecosystem	Description of Change
Seagrass meadows in Tampa Bay	81% reduction from the 1800s
Mangroves in Tampa Bay	7% reduction from 1950 to 1980
Salt marshes in Brevard County	95% were converted to mosquito control impoundments
Salt and freshwater marshes	60% reduction from 1936 to 1987
Everglades system	65% converted into a water control system
Coastal Strand	50% reduction from 1936 to 1987
Pine Rocklands	95% reduction from 1936 to 1987
Tropical Hammocks	50% reduction from 1936 to 1987
Central ridge scrub	82% reduction from 1936 to 1987
Longleaf pine forests	87% reduction from 1936 to 1987[1]

1) Only 38% of the remaining longleaf pine forests is in public ownership.

The state currently owns and manages 4.1 million acres of conservation and recreation lands, almost 12 percent of Florida's total land area. This includes lands owned by state agencies and water management districts[14] and represents an extraordinary commitment on the part of the state to the acquisition of environmentally important lands. The federal government in the past has also made substantial acquisitions of endangered areas in the state. Though not as active today, the federal government continues to purchase or assist the state in purchasing critical resource areas.

In 1994, the Florida Game and Fresh Water Fish Commission identified 4.82 million acres of high quality habitat that would meet the needs of 54 species of wildlife and 105 rare plants and designated these lands as Strategic Habitat Conservation Areas. At the time all these lands were in private ownership but since then the state has acquired almost 500,000 acres of these areas. Another 240,000 acres was acquired by the

federal government, meaning that currently about 15 percent of these lands are in public ownership.[15]

Table 4: State Acquired Lands.[16]

Program	Land preserved (acres)
CARL	345,111
SOR	504,957
SOC	72,732
P2000	1,381,616
TOTAL	2,304,416

Florida's complete system of publicly owned conservation lands now covers 8.38 million acres, over 21 percent of the land area of the state. These lands represent a foundation for the protection of ecologically sensitive and important communities and species.

Habitat Fragmentation

The increased fragmentation of the remaining patches of natural habitat poses an additional threat to wildlife. Habitat fragmentation refers to the tendency for remaining patches of habitat to become reduced in size and isolated from one another. This creates problems since some species require large tracts of habitat to survive. One example of this is the Florida panther, which has a broad habitat preference and at one time ranged throughout Florida. Although the panther preys on a number of species, it depends on the deer population within its hunting range for its reproductive success. The panther is one of the endangered species in Florida and the number of panthers is not likely to exceed twenty based on available habitat.[17]

Another effect of habitat fragmentation is the fact that as habitat is lost, the remaining patches tend to become increasingly distant from one another. If patches of appropriate habitat are sufficiently large to support a breeding pair yet are so far apart

that individuals cannot move easily from one patch to another and intermix with other members of the species, then the presence of the species across all remaining patches becomes increasingly unlikely.

Another important factor, related to habitat loss and habitat fragmentation is the creation of edges. With the concept of edge, ecologists refer to the transition between two ecosystems. An edge is the sudden change from one ecosystem to another, or the transition from an ecosystem to an urban area or road. Human activities have greatly increased the number of edges while they have reduced the occurrence of so-called ecotones. In contrast to an edge, an ecotone refers to the gradual transition from one ecosystem to another. An ecotone can describe the transition from open ground to forest, which is marked by a set of environmental gradients such as increased moisture both in air and in the soil, increased amounts of leaf litter and hence soil organic content, as well as decreased light availability, wind speed, temperature, noise, and pollution[18]. This acotone is of great importance because it offers a unique set of habitats and is often an area of considerable species richness. Furthermore, the ecotone supports a portion of the flora and fauna of both open ground and deep forests, and consequently, it may have a higher species diversity than either.[19] Habitat fragmentation increases the occurrence of edges which typically makes ecosystems more vulnerable to weather influences and the invasion of exotic species.

Endangered and Exotic Species

The loss and alteration of habitat has resulted in a dramatic decline of native species and the prolific spread of exotic species. According to recent estimates there are just 50-60 Florida Panthers left, wading bird populations have declined with 90 percent and 68 plant and animal species in the Everglades are listed as endangered or threatened[20]. Four of the ten most endangered species in the United States can be found in Florida: the American Crocodile, the Florida Panther, Key Deer and the West Indian Manatee.[21] Florida is home to a total of 561 endangered or threatened species.[22] Table 5 shows that although 457 of the endangered and threatened species are plants, mammals

seem to be most threatened with 57 percent of the mammals in Florida being listed as either endangered or threatened. In addition, according to the Florida Assessment of Coastal trends report, forty-four percent of all Florida's vertebrates are known or suspected to be declining in number or distribution.

Table 5: Endangered and Threatened Species in Florida.[23]

Species	Total	Endangered/Threatened	Percentage Endangered/Threatened
Vascular plants	3500	457	13 %
Fish	126	8	6 %
Amphibians	57	0	-
Reptiles	127	10	8 %
Birds	283	33	12 %
Mammals	75	43	57 %
Invertebrates	Unknown	10	n.a.

Genetic diversity has also been reduced in species with small remainder populations such as the panther. When human induced changes occur, the species that are least adaptable to change are extirpated first. If conditions continue to get worse, fewer and fewer species can be sustained until all that remain are the very adaptable, generalist species, such as raccoons, gulls, and cockroaches.[24] Introduction of exotic species is also observed in Florida. This leads to a very low, homogeneous diversity of life in Florida, and it means that some generalist species that did not originally live in the area may move into niches formerly occupied by extirpated species.

The ecosystems in tropical and subtropical regions are vulnerable to disturbances and invasion by introduced non-indigenous plant species. It is estimated that about 1000 of the approximate 3500 plant species in Florida are exotics.[25] These plants place a great deal of stress on Florida's unique and irreplaceable ecosystems.[26] Melaleuca is probably Florida's most destructive exotic plant species. Melaleuca trees can consume as much as 2200 gallons of water per acre per hour.[27] It was introduced in south Florida from its native Australia in the early 1900s to aid in the drainage of the

Everglades. The tree has no native pests and tolerates droughts, floods and fires enabling it to spread prolifically throughout south Florida.

Exotic plant species are not the only problem in Florida, exotic fauna also causes problems. The Giant South American Marine Toad rapidly established itself in south Florida and now threatens to out-compete the native southern toad. The non-native walking catfish has established itself from central Florida to the most southern tip of the peninsula and competes for food with other fresh water fish. The Asian Swamp Eel is one of the latest threats, which potentially can wreak havoc in the fresh water communities.

Table 6: Estimated Acreage of Water Hyacinth and Hydrilla Infestation.[28]

Year	Water Hyacinth	Hydrilla
1986	2700	13000
1987	3900	15200
1988	2000	12500
1989	1900	10700
1990	600	10600
1991	1100	9500
1992	1000	7400
1993	1100	9500
1994	900	10900
1995	1300	6000
1996	1000	4300

Because of its warm climate and abundance of aquatic habitats, Florida is particularly susceptible to infestations of exotic aquatic and wetland plants. Florida's large exotic aquarium plant and ornamental foliage industry imports millions of non-native species each year, but unfortunately many of those have escaped or been

accidentally introduced.[29] Two non-indigenous aquatic plant species of particular concern in Florida are hydrilla and water hyacinth.[30] Table 6 shows the number of acreage of hydrilla and water hyacinth infestation.

Everglades National Park alone has been invaded by over 220 exotic plant species. The main problem species are Melaleuca, Brazilian Pepper, Australian Pine and Hydrilla, all of which are widespread and have replaced native species.

Legislation

Endangered Species Act

In 1973, the United States government passed the Endangered Species Act. This was the first major law to protect animals threatened with extinction, and the only one that has authority to stop any project that jeopardizes the habitat of endangered species. This Act seeks to conserve endangered and threatened species through requiring federal agencies to ensure that their actions "do not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modifications of the critical habitat of such species."[31] An endangered species is "any species which is in danger of extinction throughout all or a significant portion of its range."[32] A threatened specie is that which is " likely to become an endangered species within the foreseeable future through all or significant portion of its range."[33]A "species" includes any species or subspecies of fish, wildlife, or plant; any variety of plant; and any distinct population segment of any vertebrate species that interbreeds when mature. Excluded is any species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of the Act would present an overwhelming and overriding risk to man.[34]

When a species is listed under the Endangered Species Act, the lead federal agency is required to issue a biological assessment whenever an action in which the federal government is involved "may affect" a listed or threatened species.[35] If the results of the biological assessment show that a listed species may be affected by the

project, the agency must consult with the Fish and Wildlife Service. In the case that a species would be affected, the lead agency must provide mitigation measures for, or alternatives to, the proposed activity.[36] Even if a "water right" exists, projects that affect such areas may be subject to Endangered Species Act regulation. Even though it is not very clear whether state water law and water rights are protected from Endangered Species Act regulation, the case law indicates that the Endangered Species Act does authorize a reduction in the power of existing water rights through regulation.[37]

Highway construction, runoff quality, mitigation activities, and maintenance may be subject to review under the Endangered Species Act if the receiving waters are considered "critical habitats." The Endangered Species Act applies to activities directly affecting water resources designated as "critical habitat" areas, and may include receiving waters from highway or urban runoff.

The National Wild and Scenic Rivers Act

The purpose of this Act is limited to the protection of "*certain selected rivers of the Nation, which, with their immediate environments possess outstandingly remarkable qualities.*"[38] It essentially provides a mechanism to determine if a river can meet certain eligibility requirements for protection as a wild and/or scenic river, and protects designated rivers from activities which may adversely impact those values.[39] The Department of Agriculture administers and designates rivers in the national forests,[40] even though the Act's framers intended for most private land's rivers to enter the Wild and Scenic River System through the State designation and management provisions.[41]

As of 1993, 32 states have conservation programs of some form where rivers and their environments are protected under State Wild and Scenic River legislation. As a result, many state regulations prohibit or restrict dams, protect designated rivers from canalization or diversion, or have instituted comprehensive controls for land use planning, water quality and waste-control, transportation planning and local zoning requirements. Highway construction and operations near designated river segments are

subject to restrictions developed by the state. Even if such activities are temporary, any disruptions to the normal flow of the river, increased sediment loads, or significant increases to pollutant loads, may be restricted by state-enacted Wild and Scenic Rivers Act.[42]

National Environmental Policy Act

The National Environmental Policy Act (NEPA) was designed to create a vehicle for considering environmental amenities consistent with other national needs, such as economic development, in a systematic manner.[43] NEPA establishes judicially enforceable obligations which require all federal agencies to identify the environmental impacts of their planned activities. Under the Act, federal agencies are required to determine whether a proposed action constitutes a "major Federal action which will significantly affect" the quality of the human environment.[44] The organization has to conduct a preliminary investigation of the potential environmental effects and report it in an environmental assessment (EA), or an environmental impact statement (EIS), in order to determine if further investigation is required. NEPA requires federal agencies to conduct preliminary environmental impact analysis as early in the planning process as possible, and prior to the undertaking of the project or action.

Highway operations and projects are subject to the NEPA process and environmental concerns must be considered before implementation. The NEPA legislation is the protector under which environmental impacts are evaluated for all substantial federal projects.

ISTEA and TEA-21

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) includes measures and policies requiring or encouraging an approach to transportation development which integrates considerations for management of both the natural and

constructed environments. ISTEA, through measures in the Transportation Improvement Program, encourages Metropolitan Planning Organizations, local, and state transportation agencies to involve the public and other resource management and development concerns in long-range transportation planning. It also requires that transportation agencies consider the likely effects of transportation policy decisions on land use and development, and the consistency of transportation plans and programs with the provisions of all applicable short- and long-term land use and development plans. In a sense, these provisions incorporate an ecosystem approach into highway planning, resource development, and land-use by moving land use decisions to the front end of the transportation planning process. This should encourage better decision-making processes and long range planning for both transportation and land use development compatible with sustainable ecosystem productivity and integrity.

ISTEA provides clear and specific authority for advance inventory of wetlands resources, participation in local and regional planning efforts for management of wetlands ecosystems, and development of mitigation banks for mitigation of unavoidable wetlands impacts. It also establishes the eligibility of mitigating impacts on other natural ecosystems and wildlife habitat for federal-aid funding. All of these approaches support an ecosystem management concept.

TEA-21 builds upon the planning provisions of ISTEA to assure that environmental considerations are part of the decision making process. Although it increases funding for the Congestion Mitigation and Air Quality Improvement as well as the Transportation Enhancements Programs, TEA-21 does not include specific provisions for ecosystem protection and ecosystem management but does call for environmental streamlining and better integration of transportation and community planning. [45]

Effects of Transportation on Wildlife and Habitat

Introducing roads and associated infrastructure into the environment has led to the destruction or disruption of habitats in the right-of-way. Roads damage existing vegetation, interfere with wildlife crossings, displace forests and communities of animals and birds, and alter the hydrology of various areas, including drainage, permeability, and stream flow patterns.[46]

Highway construction has also been cited as an activity that contributes to wetlands destruction and loss of mangroves, seagrass, marshes, and swamps –habitats that support a diverse range of species and provide other desirable functions such as flood control.[47] In the past 200 years, the U.S. has lost over half of the original wetlands acreage in the 48 contiguous states. In recent years, 300,000 acres have been lost annually, or a 3 percent loss per decade. Over half of these recent losses have been caused by conversion to agricultural use, and only 4 percent were identified as conversion to urban land. The amount of wetlands acreage lost annually is over 20 times higher than the amount of new land used by roads.[48]

According to the Florida Department of Transportation, over the last 50 years Florida's high-speed paved roads have increased at the rate of 4.5 miles per day. The newest roads are all the more damaging because they are wider and allow even faster travel. These and other barriers make it difficult for animals to use all parts of their habitat. Sometimes populations are trapped in areas too small to support them. This is especially true of species such as bears that require a wide range. Confined to inadequate space, the animals are likely to be wiped out by natural disasters such as floods, fires, too much heat or too much cold.[49]

Construction of roads can also reduce water storage and spring flow, threatening species during droughts. When natural ground cover is present over an entire site, normally less than ten percent of the storm-water runs off into nearby rivers and lakes. As paved surfaces increase, both the volume and rate of runoff increase. When paved surfaces cover ten to thirty percent of the site area, approximately twenty percent of the

storm-water can be expected to run off.[50] Pollutants washed from land surfaces and are carried to lakes and rivers by runoff, which may add to existing water quality problems. In addition, paved surfaces prevent natural infiltration of storm-water into the ground.

Other road transportation infrastructure, such as buildings and bridges, also may have habitat impacts. For example, bridges and stream crossings are likely to have significant impacts on hydrology and aquatic habitat. However, the physical extent of roads is far greater than that of buildings and bridges.[51]

The environmental impact of a particular project depends on the location and condition of the surrounding area, the size and type of road constructed, and the duration of the project. The construction of the facility itself may cause changes in turbidity, suspended solids concentration, and color of receiving waters. Temporary storage facilities for equipment and supplies used during the construction phase may also damage vegetation and displace communities of animals. However, it is important to keep in mind that it is very difficult to isolate from the effects of land-use changes, socioeconomic changes, and natural ecological changes in receiving water bodies.[52]

Florida's rapidly growing population is causing increasing demands on natural systems. Urban water uses are drastically rising, and urban sprawl is fragmenting and degrading habitats. Due to the relationship between the environment and our economy, environmental damage harms the economy. The value of protecting Florida's environment, however, cannot be readily measured in dollars, because the benefits of a functioning environment are not adequately valued under our current method of economic accounting. Besides, many benefits of environmental protection are intangible or aesthetic.[53]

Road Impacts to Wildlife and Habitat

Roads fragment landscapes may become a barrier to dispersal, both because they are an alien surface and also because animals may be killed crossing the road.[54] The most evident impacts of roads on wildlife and habitats can be categorized as follows:

1. Roads cause direct animal mortality through collisions with vehicles (roadkill).
2. Roads expedite the conversion of surrounding lands to development.
3. Roads fragment wildlife habitat, isolating populations and decreasing the chances of survival of the fragments.
4. Roads complicate the management of remaining habitat fragments (e.g., fire management), compromising the quality of the habitat and its value to wildlife.
5. Roads alter animal behavior by causing changes in home ranges, movement, reproductive success, escape response, and physiological state.
6. Roads may provide habitat and movement corridors for opportunistic species of plants and animals. Roads can provide corridors of disturbance and seed transport for exotic species of plants.
7. Roads increase human access to natural areas, increasing disturbance to wildlife.
8. Roads affect the physical environment: change the soil density, temperature, soil water content, light levels, surface waters, patterns of runoff, sedimentation, and create dust in their immediate environment.
9. Roads affect the chemical environment: add heavy metals, salts, organic molecules, ozone, and nutrients to roadside environments.
10. Roads pollute air and water, and impair aquatic ecosystems.
11. Road construction displaces and kills plants and animals.

Pollution from roads begins with construction. An immediate impact is noise from construction equipment, and noise remains a problem along highways with heavy traffic. Animals respond to noise pollution by altering activity patterns, and with an increase in heart rate and production of stress hormones. Sometimes animals become habituated to increased noise levels, and apparently resume normal activity. But birds and other wildlife that communicate by auditory signals may be at a disadvantage near roads. Highway noise can also disrupt territory establishment and defense.[55]

Many studies have documented increasing levels of lead in plants with proximity to roads, and with increases in traffic volume.[56] Plant roots take up lead from the soil and leaves take it up from contaminated air or from particulate matter on the leaf surface.

This lead moves up the food chain, with sometimes-severe toxic effects on animals, including reproductive impairment, renal abnormalities, and increased mortality rates. Less is known about the effects of other heavy metals, such as zinc, cadmium and nickel. Motor oil and tires contain zinc and cadmium; motor oil and gasoline contain nickel. These metals like lead, have been found to increase with proximity to roads, and with increasing traffic volume and decreasing soil depth. Earthworms have been found to accumulate all these metals in concentrations high enough to kill earthworms-eating animals. These roadside contaminants can be carried far from roads by wind and water.[57]

The Everglades: A Special Case

Although ecosystems fragmentation is a problem that affects the whole state of Florida, the Everglades are of special consideration due to its uniqueness and influences over the fastest growing South Florida. The wildlife habitat value of the Everglades wetland system as a whole is extremely important. It serves as a permanent refuge for a great diversity of wildlife including numerous endangered species.[58]

The Everglades and South Florida ecosystem in general are uniquely dependent on the area's distinctive water flow pattern.[59] When people began to disrupt this pattern, the health of the ecosystem began to deteriorate.[60] The wetlands of South Florida were regarded as being inhospitable and without intrinsic value. In the early 1900's, draining the wetlands was considered to be essential for commerce and safety. Drainage projects were accelerated by the result of hurricanes in the 1920's. Nowadays, much of South Florida's wetlands are intensively managed, with more than 1,400 miles of primary canals and more than 100 water control structures.[61] The effects of the drainage and development of the region include a variety of environmental problems such as loss of soil, nutrient enrichment, contamination by pesticides, mercury buildup in the biota, fragmentation of landscape, loss of wetlands and wetland functions, widespread invasion by exotic species, increased algal blooming in coastal waters, seagrass die off, and declines in fishing resources.[62]

In addition, the hydrologic changes have disrupted wading bird nesting, which depends on concentrated food supplies that occur under normal dry-season conditions.[63] Loss of wetlands in South Florida has also reduced landscape heterogeneity, habitat options, and long-term population survival for animals with large spatial requirements. Wading birds, snail kites, and panthers, for instance, have become increasingly stressed by the fragmentation and loss of habitat.[64]

The Everglades possesses a great biological significance while its effects on the economy of South Florida cannot be ignored. If current patterns of damage continue in the Everglades, area officials have warned that the economic impact could be substantial.[65]

Conclusion and Discussion

With the growing population in Florida it is likely that conflicts between preservation and transportation will increase. It is also likely that road designs will increasingly have to include components that can mitigate possible negative effects on wildlife. Given the large number of endangered and threatened species in Florida, the Endangered Species Act could have a substantial effect on the construction of new roads or road widenings. The challenge for Florida is to protect its unique natural resources while providing for its growing population. The challenge for transportation is to provide for mobility for Florida's population while preserving the increasingly sparser natural areas.

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Executive Summary

In 2000, the Florida Department of Transportation (FDOT) contracted with the FAU/FIU Joint Center for Environmental and Urban Problems to write a series of white papers on trends and conditions of transportation impacts on land use and the environment. This is one of several reports requested by FDOT that specifically focuses on the regulatory framework surrounding the process of planning land uses and transportation in the state of Florida. Several trends were identified as being important to the focus of future policy regarding land use and transportation planning in the state.

Historically, transportation planning has done little to evaluate how the continuous construction of additional transportation infrastructure is impacting urban form. Transportation planning has primarily used roads as the means for meeting the transportation demand created by land uses.[1] Meanwhile, land use planning has been viewed as a separate entity altogether since land use is strictly a matter of local jurisdiction. Combined, transportation plans and local land development regulations have been producing sprawling low-density residential and commercial areas that rely almost exclusively on the use of cars and roads to move people around. This new growth has spread along highways, stretching boundaries and urban form, and significantly increasing the cost of additional infrastructure.

Because of the interdependent relationship between land use and transportation, the goals and tools for implementing land use and transportation plans often overlap and affect one another but do not necessarily correlate with each other's vision. Florida has tried to reign in its intense development with growth management strategies. Land use and transportation planning are both components of three levels of growth management plans: state, regional, and local. At these three levels, many government agencies are directly and indirectly involved in producing and implementing the plans. Most of them focus on specific issues, as is the case of the Florida Department of Transportation, the Florida Department of Community Affairs, the Department of Environmental Protection, and the Water Management Districts. Others, such as the Metropolitan Planning Organizations (MPOs) and Regional Planning Councils, use their

role as regional agencies to provide a forum for cooperation and coordination; however, their lack of jurisdiction leaves all decision making to local government. This is the level where the rubber hits the road when land use and transportation physically come together. At this level coordination is imperative, but mired in parochialism, it has yet to fulfill its full potential.

Despite the existence of a coordinated state planning system, existing policies and regulations still lack the provisions needed to coordinate transportation and land use plans and projects. Changes in urban policy and design require mutual support from land use and transportation efforts. Many state and regional committees and initiatives have concluded that, as a result of past land use and transportation decisions, urban development continues to voraciously consume open space, increase costs, and contribute to land, air, and water pollution. In 1999, the Florida Transportation and Land Use Study Committee (TLUSC) concluded that, "*the optimized, segregated and specialized approach to planning, although presumed internally consistent, is not concerned with achieving a predetermined vision or community objective and often has not created communities where people are comfortable and proud to live.*" [2]

The most important trend identified in this report is the desire of state and local governments to transform their communities into livable places that are pedestrian friendly, offering the public a higher quality of life. An important step in this process is coordinating land use and transportation decisions so that they are mutually supportive and promote more efficient use of local infrastructure and resources.

Review of different planning processes conducted by the state's agencies and departments reveals that avenues for coordinating land use and transportation planning exist. However, these avenues only run across the top and bottom rungs of the planning structure and do not bridge the divide at the regional level. Coordination of regional land use and transportation planning is needed to provide regional solutions to congestion, transportation alternatives for commuters, and supportive land use patterns to help

maintain a strong state and regional economy, because these issues transcend local and metropolitan boundaries.

Other specific trends identified include the following:

- Creation and/or strengthening of regional decision making bodies to implement regional solutions, such as the Regional Transit Organization in Southeast Florida that provides commuter services connecting Miami-Dade, Broward and Palm Beach Counties.
- The need for a more formal, structured dialog between MPOs on regional issues that cut across MPO boundaries, such as the management of the I-4 Corridor Initiative that involves public and private interests.
- The need for new strategies at the regional level to achieve mutually supportive land use and transportation solutions, such as a regional land use plan.
- The need for resources to implement new strategies at the local level, such as rewriting local land development regulations (zoning codes) that will produce innovative urban designs that are more transit-supportive and pedestrian-friendly where people can rely less on their cars.
- Changes to the concurrency mandate as it relates to transportation facilities, particularly in light of the fact that higher density and intensity development in urban activity centers make mass transportation alternatives feasible and desirable.
- Using reductions in transportation impact fees as an incentive for promoting innovative development patterns and designs that are less auto dependent.

In conclusion, as a means for achieving the 2020 Florida Transportation Plan (FTP) goal of enhancing quality of life, the department could help local communities and regional authorities understand the need to address the reciprocal relationship between

transportation and land use through multiple planning levels, changes in the planning process, and innovations in land use planning and urban design.

The Planning Process

Historically, transportation planning has been conducted in the context of providing better access to, from, and around cities, primarily for economic purposes. Early stages of transportation planning were restricted to assessing the needs of the regional market, particularly in relation to interstate or international trade, and often overlooked the importance of planning for the quality of life of the individual communities along the way. Transportation planning has done little to evaluate how continuous construction of additional infrastructure has impacted urban form. Transportation planning has primarily used roads as the means for meeting the transportation demand created by land uses;[3] land use planning has been viewed as a separate process.

Land use planning began generally in the context of providing municipal services and protecting the value of residential neighborhoods. Land use is strictly a local matter and only local elected officials have final jurisdiction over land use decisions. Within the city, zoning and other regulations define the location of separate districts for each type of land use, namely residential, business, and industrial.[4] Over the past 50 years urban development has been characterized by segregated land uses and low-density sprawl. The outward expansion of cities has occurred as a result of developing homes on less expensive tracts of land at the urban edge, paving the way for commercial and other business uses. The move has naturally occurred along the lines of new and existing highways, spreading urban service boundaries and eventually increasing demand and the cost of additional infrastructure. Local governments that welcomed this new growth often failed to see its negative impacts or lacked the understanding of how to deal with it.

The same market forces that drive urban growth seem to be driving transportation infrastructure. Because of their interdependent relationship, the goals and tools for implementing land use and transportation plans often overlap and affect one another but do not necessarily correlate with each other's vision. Today, transportation

planners cannot continue to view transportation services in an isolated manner, just as land use planners cannot afford to let the market alone direct where and how development will occur. The reciprocal association must be recognized when drafting land use and transportation plans.

As Florida has tried to reign in its intense development with growth management strategies, the need to address the land use and transportation relationship is becoming more evident in the planning process. Despite the context of a coordinated state planning system, land use and transportation policies and regulations still lack the emphasis needed to achieve coordinated plans and decisions. Furthermore, just as transportation planners in Florida have not made serious progress in implementing multimodal transportation systems to address demand, land use planners have had little effect on rearranging the urban landscape and curtailing outward growth. These changes require mutual support from land use and transportation efforts.

Many state and regional committees and initiatives have concluded that, as a result of past land use and transportation decisions, urban development continues to voraciously consume open space, contribute to land, air, and water pollution, and increase costs. Despite the obvious warning signs, it appears that the state's decision makers still view transportation and land use planning as separate entities, and local decision makers lack the will to focus on a future that is potentially longer than their political lives.

In 1999, the Transportation and Land Use Study Committee (TLUSC), created in 1998 by legislative mandate and appointed jointly by the secretaries of Community Affairs and Transportation, concluded that, "*the optimized, segregated and specialized approach to planning, although presumed internally consistent, is not concerned with achieving a predetermined vision or community objective and often has not created communities where people are comfortable and proud to live.*" [5]

This report will look at the conditions surrounding the relationship between the process of planning land uses and transportation in the state of Florida. The analysis will lead to the identification of issues and trends that should be the focus of future policy regarding land use and transportation in the state.

Florida Levels of Planning

Florida is a mandatory planning state. Land use and transportation planning are both components of three planning levels in Florida: state, regional, and local. Early growth management initiatives established the importance of planning at the state level. Later revisions in Florida legislation provided funding sources for regional and local planning. Local government became accountable to the region and the state for its development patterns through the development of local comprehensive plans. The governor, as the chief planning officer of the state, provides guidance to the state and regional agencies to coordinate transportation and infrastructure with land use and community design.[6] Regional and state agencies then have the responsibility of guiding local governments in planning and coordinating transportation and land use development.

A variety of state, regional, and local agencies are directly and indirectly involved in producing local land use and transportation plans. Most agencies focus on specific issues that indirectly affect land use and/or transportation, as is the case of the Florida Department of Transportation (FDOT), the Florida Department of Community Affairs (DCA), the Department of Environmental Protection (DEP), and the Water Management Districts (WMDs). Others, such as the Metropolitan Planning Organizations (MPOs) and Regional Planning Councils (RPCs), use their role as regional agencies to provide a forum for cooperation and coordination. The rubber hits the road at the local level, where land use and transportation physically come together. While coordination is imperative at this level, it has yet to fulfill its full potential.

The following is a review of the role of the various entities involved in the planning processes of transportation and land use at three levels of government within the state of Florida, and at the federal level, where it relates to the state planning system.

Florida Transportation Planning

Transportation in Florida is planned in two directions: "top down" and "bottom up." In top down planning, federal funds are distributed to local governments through the state transportation planning agency, the Florida Department of Transportation, based on a funding formula that includes the state transportation plan. This plan is a product of decisions made by local government and Metropolitan Planning Organizations, which determine funding needs and how the money will be spent over the short- and long-terms. This, in essence, is the bottom up component. In addition, there are other agencies that directly or indirectly affect transportation plans and planning.

Federal Level

Federal transportation laws have been enacted every five to six years to provide authority for new federal programs or modify existing programs. The programs divide and allocate funds for state, regional, and local governments across the country based on a funding formula, which dictates how funds can be spent. The 1956 Federal Highway Act provided federal funds that rewarded states for road construction and "penalized" them for investing in public transit and other alternatives to the automobile.[7] States received a smaller amount of federal assistance for public transportation initiatives and other non-automobile transportation projects.[8] The Interstate Highway System, created by the 1956 Act, encouraged development around towns and in some places bulldozed whole or parts of old towns to expand highways.

In 1991, the federal government passed the Intermodal Surface Transportation Efficiency Act, also known as ISTEA. This was the first federal transportation act that required transportation to include land use planning in transportation projects.

Formulated from the desire to please interest groups, environmental groups, and the federal "wallet," ISTEA represented a departure from earlier transportation planning approaches at the federal level. It was developed to make the transportation planning process more inclusive and responsive. Because it became apparent that funding for highway expansion projects was becoming scarcer, ISTEA called for less funding for new highway expansion and more attention to comprehensive transportation planning. The new approach to planning considers alternative modes of transportation, such as transit and bicycle and pedestrian trails in addition to maintaining existing roads and managing traffic.[9]

In 1998, the U.S. Congress passed the Transportation Equity Act for the 21st Century, TEA-21, which continues many of the programs that were initiated by ISTEA, including the promotion of alternative modes of transportation, such as pedestrian, transit, bicycle, and rail. TEA-21 will provide the Florida Department of Transportation $7.3 billion between 1998 and 2003, almost $1.2 billion per year, to finance construction and repair of the state's highways. In addition, TEA-21 will also direct money to promote transit initiatives within the state.[10] Like its predecessor, TEA-21 requires comprehensive transportation planning at all levels of government.

State Level

At the state level, several agencies are engaged in planning Florida's development, including transportation and land use needs. Major state departments currently involved in transportation and land use planning include the Florida Department of Transportation, the Department of Community Affairs, and the Department of Environmental Protection.

The Florida Department of Transportation and the State Transportation Plan

The Florida Department of Transportation sets priorities for transportation projects at the state level; however, regional Metropolitan Planning Organizations, or in absence of an MPO, the County Commissions, provide the input for prioritization through their local and regional transportation plans. FDOT is composed of a state office, seven decentralized district offices, and the Turnpike District Office, all of which are responsible for designated facilities and areas.

As noted above, transportation planning is required to fit into the context of the state comprehensive planning system, and plans are developed through a top-down and bottom-up process. At the state level, FDOT writes the Florida Transportation Plan (FTP). The plan spans a 20-year period and sets long and short-range transportation goals and objectives based on federal and state policies. By state law, this plan must be consistent with the State Comprehensive Plan's goals and policies and any other statutory mandates and authorizations.[11] Chapter 339 of the Florida Statutes also requires the FTP to preserve the existing transportation infrastructure, enhance Florida's economic competitiveness, and improve travel choices to ensure mobility.

Currently, the 2020 FTP sets the policy framework for the Department's annual budget and five-year work program. The budgets and work programs are developed through input at the local level from Metropolitan Planning Organizations. MPOs determine future transportation demand and needs relying on local demographic and land use data from the comprehensive plans and the use of transportation models with the input of local governments.

Four goals are currently defined in the 2020 FTP: safety, system preservation and management, enhancing economic competitiveness, and enhancing quality of life. In the plan, the last goal recognizes the increasing demand for:

- greater compatibility between transportation facilities and communities;
- more reliance on alternatives to single-occupant vehicles; and

- better coordinated transportation and land use decisions to encourage more efficient land development and travel options.[12]

Although the plan describes design options that could be used to resolve compatibility and reliance issues, it stops short of addressing how transportation and land use decisions will be coordinated.

FDOT is also involved in planning the state's intermodal transportation system, which includes all major transportation components: ground transportation (intrastate highway system and rail), airports, and seaports. From the need to set aside more land for transportation improvements through the impact they have on current and future land uses and growth, all transportation elements directly affect land use planning.

Several state level programs and departments address and plan different modes of transportation including the agency strategic plans for transit, aviation, rail, and the Statewide Intermodal System.[13] Florida seaports are another example of these specific plans. The Florida Seaport Transportation and Economic Development Council, created under Chapter 311, F.S., must prepare a five-year plan defining the goals and objectives of the development of port facilities and its relationship with the intermodal transportation system. The plan is updated annually and submitted for review and approval to the President of the Senate; the Speaker of the House of Representatives; the Office of Tourism, Trade, and Economic Development; the Department of Transportation; and the Department of Community Affairs.

The Department of Community Affairs

The Transportation Planning section of the state's Department of Community Affairs is responsible for coordinating the review of the Metropolitan Planning Organizations' five-year transportation improvement plans, FDOT's five-year work program, and other transportation plans, projects, and proposals to determine consistency with adopted local comprehensive plans. The staff provides technical assistance and reviews amendments to local governments regarding transportation

planning and concurrency management systems. They also review Developments of Regional Impact (DRI), including transportation and concurrency issues.

The Department of Environmental Protection

When dealing with land use, environmental issues undoubtedly arise. With wetlands covering potential development areas, transportation and land use planning must also engage in environmental planning. By law, FDOT is required to document potential impacts of proposed infrastructure improvements on the environment in its environmental impact inventory, particularly when the proposed road construction is on or near environmentally sensitive land or ecosystems. When the environmental mitigation for the impact of proposed FDOT projects can be more effectively achieved by regional, long-range mitigation planning than on a project-by-project basis (Chapter, 373), FDOT is required to send the inventory information to the Department of Environmental Protection. This triggers DEP's involvement in the planning process as well.

Regional Level Transportation Planning

State and regional planning exists in Florida because the problems of growth and development are not confined within specific boundaries and the effect of local policies transcends beyond their political boundaries. Regional issues in Florida are the concern of several agencies, including the Metropolitan Planning Organizations, Regional Planning Councils, Water Management Districts, and the district offices of FDOT.

Metropolitan Planning Organizations

Metropolitan Planning Organizations are agencies whose membership includes local elected officials and state and local transportation, environmental, and planning

offices. MPOs may have a range of responsibilities but their primary focus is on transportation. Although they do not have authority over land use, they must consider future uses when conducting planning activities. Their primary responsibility is to develop transportation plans and improvement programs for their metropolitan areas.

The evolution of MPOs relates directly to mandates of different Federal Highway Acts, beginning with the Act of 1962. This Act required that highway projects in communities exceeding populations of 50,000 would only be funded if they were planned as part of a regional transportation planning process that was comprehensive, continuing, and included the cooperation of states and the local communities.[14] Progressive regions trying to do a better job of managing rampant growth seized on the mandate and created their own versions of MPOs even though funding sources were not provided until 1973. The Act of 1978 mandated the creation of comprehensive transportation plans based on needs, as well as comprehensive long-range land use plans and social, economic, environmental, and energy conservation goals.[15]

Currently, the federal government distinguishes organizations by the size of the area they serve. Metropolitan areas of 200,000 or more are also known as Transportation Management Areas (TMAs). These areas receive priority in funding, but are required to adopt a congestion management system.

MPOs are accountable to both the state and federal government. Federally required documents from MPOs include the Long-Range Transportation Plan and the Transportation Improvement Plan (TIP). While the state transportation plan must be consistent with the state comprehensive plan, the issue of the MPO plans is somewhat vague. Florida legislation does not bind local MPO plans to local comprehensive land use plans.

The long-range plan identifies all major transportation projects that are regionally significant, such as highways, transit pedestrian trails, and rail. This plan is required to take into account factors that affect transportation, such as land use and population

growth. The Transportation Improvement Plan is similar to the long-range plan but must be updated every two years. Unlike the Long Range Plan, the TIP must list funding sources and rank transportation projects.

ISTEA began requiring MPO plans to address high priority corridors as well as corridors that needed preservation. MPOs can provide technical assistance to local governments in the designation of corridor areas. They can facilitate state and local coordination while promoting local awareness on corridor management. MPOs may recommend minimum density guidelines for development along designated public transportation corridors and identify investment strategies for providing transportation infrastructure where growth is desired, rather than focusing on relieving congestion where growth is discouraged. The movement toward corridor management will be discussed in more detail later in this section.

Regional Planning Councils

Regional Planning Councils are similar to MPOs in that they also provide technical assistance to local governments on land use and transportation issues. Through RPCs, local governments can recommend changes to state policy. Under Chapter 186, F.S., RPCs are charged with:

- Preparing a Strategic Regional Policy Plan (SRPP) to guide local comprehensive plan policies;
- Establishing and conducting a cross-acceptance negotiation process with local governments intended to resolve inconsistencies between applicable local and regional plans, with voluntary participation by local governments;
- Coordinating land development and transportation policies in a manner that fosters regionwide transportation systems; and

- Reviewing plans of independent transportation authorities and MPOs to identify inconsistencies between those agencies' plans and applicable local government plans.

In addition, RPCs are recognized as Florida's only multi-purpose regional entity in position to plan for and coordinate intergovernmental solutions to growth related problems. The SRPP discusses a variety of goals and policies for the region relating to many elements including land use and transportation. The plans are developed with input from local government and residents and are reviewed by DCA for consistency. The SRPP includes analyses of land use, both built environment and natural resources, as well as regional transportation. Regional plans must be consistent with the state comprehensive plan.

RPCs also have the responsibility of supporting strategies and policies that consider the multi-dimensional aspect of all modes of transportation and promote multi/intermodal transportation systems. The South Florida RPC's (SFRPC's) 1995 Strategic Plan proposes that the transportation system should be viewed in the overall larger picture of sustaining a livable community. To accomplish this, land use and transportation planning need to be coordinated. Future investments should include land for highway and mass transit corridors. Local governments should coordinate with state officials to identify public transportation corridors. Furthermore, they should promote development along those corridors by implementing investment strategies to provide infrastructure and by allowing higher densities to support the investments. One of SFRPC's goals is to promote compact urban growth and protect the natural environment by focusing growth in areas and corridors where existing infrastructure is underused.

District Offices of the Department of Transportation

District offices of the Florida Department of Transportation also operate at a regional level and limit their focus to the transportation infrastructure and service

demands of their district. As with the state level, FDOT district offices do not have the legislative authority over land use decisions within their respective districts. Each district is headed by a District Secretary and is responsible for providing operation assistance to the transit authorities, water ports, public and private airports, and seaports. All of this is done in addition to overseeing the district's roads and highways. Each FDOT district office must deal with the multiple MPOs that operate within their boundaries.

FDOT district offices are responsible for all of the studies and plans required to build or improve a facility. The number of studies and plans required depends on the size of the project and the potential impacts. Current law also requires that FDOT provide opportunities for public participation. All of these elements conspire to create a cumbersome planning process. It takes years to plan a facility, in addition to finding the resources to finance the project. More often than not, the facility quickly reaches capacity soon after it is built because of the land use decisions being made in the interim. These factors make it difficult to coordinate the transportation planning process with local planning processes.

Local Government and Transportation Planning

In local government, several documents regulate transportation and transportation plans. Each county and municipality has a local comprehensive plan that contains the policies and goals for 11 mandated elements including land use and transportation.[16] The transportation element of each plan also contains maps that rank local roads and transit service, airports, and seaports, where applicable. Proposed improvements to these facilities appear in separate plans and in the local government's capital improvement plan, in addition to appearing in the MPO's plans.

The most criticized components of the comprehensive plan are the concurrency requirements. Transportation is one of the services that are required concurrently with the population it will serve. Developers must not only provide onsite transportation infrastructure, but also mitigate for the increase in number of trips their proposed

development will put on the existing roadway network. To avoid costly improvements to other roadways, development has sought locations where the existing roads provide excess capacity. This has helped promote sprawl and low-density development.

Local governments may make amendments to their plans twice a year. Every seven years, each local government must develop an evaluation and appraisal report to assess progress made in implementing the comprehensive plan. This report must contain proposed or implemented improvements to government services that reflect changes in population, as well as future projections.

Each local government establishes a local planning agency and planning boards that are advisory to the local legislative body or commission. Within the governmental structure, the planning agency can be found at a level either directly below the city manager, the council or commission, or the mayor. However, land use decisions are legislative and under the jurisdiction of the commission.

In addition to the comprehensive plan, local governments use their zoning, subdivision, and building codes to establish design and building standards and requirements for parking and roadway improvements. Although most codes limit requirements to minimum street width, sidewalks, and construction, some communities are beginning to address design and are adding elements, such as wider sidewalk requirements in urban settings, bike lanes, and street trees.

Toward Corridor Management

In 1995, state and local planning law was amended to promote an expanded local role in corridor management. Instead of designating corridors for preservation in the Florida Transportation Plan, corridors would be designated in local comprehensive plans. Emphasis moved from corridor preservation to corridor “management.” Protection denotes the limiting of development completely, while management refers to providing

compatible development along the designated corridors. Essentially, it involves right-of-way preservation, advance acquisition, and access management techniques.

According to Florida planning law, Chapter 163.3164(30), F.S., "*corridor management is the coordination of the planning of designate future transportation corridors with land use planning within and adjacent to the corridor."* The coordination is deemed important because of the interdependent relationship between transportation and land use. Through corridor management, planning entities can prevent or minimize development within a right-of–way of a planned transportation facility, acquire a right-of-way in advance of construction time, and preserve the safety and efficiency of existing facilities through access management.

In 1996, FDOT enacted corridor management to guide districts and local government agencies in designating corridors and adopting corridor management ordinances. The state procedure requires that FDOT identify high priority corridors in its Corridor Management Report and prioritize them in the Corridor Management Lists.

Types of individual corridor plans include:

- Corridor Management Plans
- Thoroughfare or Access Management Plans
- Traffic Ways Plans

Corridor management takes shape in the transportation element of the comprehensive plan with goals, objectives, and strategies for policies that promote corridor management. The transportation element can also include a future transportation map that depicts the location and designated corridor dimensions to guide development permits.

The Florida Intrastate Highway System (FIHS) is also a product of the move toward corridor management. The FIHS was developed in 1990 by the Florida legislature to include transportation infrastructure that is essential to the economic

health of the state and serves as the backbone to the Florida Strategic Freight Network by linking seaports, airports, rail, and other intermodal/freight facilities. The FIHS Plan, Chapter 338, F.S., delineates a statewide system of corridors for limited-access facilities and controlled-access facilities that must be consistent with the goals of the Florida Transportation Plan.

Florida Land Use Planning

Florida's rapid growth during the 1960s and 1970s led to the enactment of landmark growth management legislation adopted in 1985. The Growth Management Act requires three levels of planning: state, regional, and local. Local governments adopt a comprehensive local plan and associated land development regulations consistent with regional and state policies. It also requires local governments to ensure that the forecasted needs for roads, water, sewer, and other facilities, are met concurrently with the growth they serve. Consistency between local, regional, and state planning activities is achieved through intergovernmental coordination and cooperation. This means that planning for urban development, transportation facilities, water management, and environmental protection should be done in coordination with each other while accounting for mutual impacts.

In general, local governments under the direction of regional policies and state legislation conduct land use planning. Comprehensive plans define the location of current and future land uses on future land use map and through their policy sections, to guide their land use and permitting decisions. Future facility spending (capital investments) for roads, sewer, water, and other local facilities, is also included in the comprehensive plan, which is updated annually. By law, comprehensive plans are updated every seven years, but can be modified twice a year.

The State Comprehensive Plan

The State Comprehensive Plan describes the goals and policies of the state regarding environmental protection, meeting the needs of its population, and maintaining a strong economy. The land use element of the state plan directs development to take place in areas that have the resources, fiscal abilities, and service capacity to accommodate growth "in an environmentally acceptable manner." The transportation element directs future transportation improvements "to aid in the management of growth" and integrate multiple modes of transportation. While it has been made clear thus far that land use and transportation decisions need to be coordinated with the state comprehensive plan, the respective elements do not directly contain language emphasizing such coordination. Only in the Urban and Downtown Revitalization element did we find language that supports the reciprocal relationship between land use and transportation under the list of policies, as follows:

- "Enhance the linkages between land use, water use, and transportation planning in state, regional, and local plans for current and future designated urban areas." (Policy No. 6)

- "Encourage the development of mass transit systems for urban centers, including multimodal transportation feeder systems, as a priority of local, metropolitan, regional, and state transportation planning." (Policy No. 9).

Other policies, which could be broadly interpreted as promoting land use and transportation linkage, include:

- "Develop concurrency requirements that do not compromise public health and safety for urban areas that promote redevelopment efforts" (Policy No. 7) where relaxing concurrency requirements allow denser development in urban areas.

- Locate appropriate public facilities within urban centers to demonstrate public commitment to the centers and to encourage private sector development, where transportation improvements could be interpreted as public facilities.

The State Planning Agency

The Department of Community Affairs, by law, is Florida's land planning agency and is responsible for guiding the state's growth. The department's Division of Community Planning plays a lead role in supervising the administration of and enforcing the state's growth management policy. DCA serves as an umbrella agency for all development regulation that affects the state.

DCA has programs that concentrate on specific areas in planning. Programs related to land use and transportation planning at the state level function under the Division of Community Planning's Bureau of State Planning. The Bureau provides assistance in the areas of land use and transportation, performs research, and participates in the DRI review process. The land use section staff supplies technical review and guidance to state, regional, and local efforts that involve land use, water-related issues, natural resource protection, wildlife mitigation, hazard mitigation, and transportation.[17] Other responsibilities of the land use staff include, serving as an agency liaison on environmental issues and working with other agencies and local governments in identifying the best management practices to mitigate the land use impact of Developments of Regional Impact.[18]

The Department of Environmental Protection is responsible for the implementation of most of Florida's environmental regulations, including air monitoring and assessment, as well as development related issues with respect to environmental impacts and water management.

Implementation of the State Comprehensive Plan—Rule 9J-5

The Florida Administrative Code implements Florida laws in the form of rules. The most important rule regulating local land use is Rule 9J-5. It provides the minimum criteria for review of local government comprehensive plans and plan amendments, evaluation and appraisal reports, land development regulations, and determinations of compliance.

Other Florida Laws that Affect Land Use Planning

Below is a list of key growth management laws passed in Florida over the last 30 years and key measures that affect land use planning in the state.

- Planning and Zoning Enabling Legislation in Florida - 1969
- Environmental Land and Water Management Act - 1972
- Water Resources Act of 1972
- Land Conservation Act of 1972
- Local Government Comprehensive Planning Act - 1975
- Local Government Comprehensive Planning and Land Development Regulation Act (Growth Management Act) - 1985
- "The ELMS Law": Revisions to the 1985 GMA based on the recommendations of the Environmental Land Management Study Committee - 1993.

Regional Land Use Planning

The Regional Policy Plans

Recognizing that there are regional differences, regional policy plans interpret the state comprehensive plan in a manner that relates to local characteristics and needs. The regional plan is supposed to provide guidance for local comprehensive plans, and the local plans are reviewed against it. It is also composed of goals and policies based

on an assessment of the region's resources and needs; however, it does not contain a land use plan or a transportation plan per se. It continues to be a general policy framework for local planning. Moreover, some regional plans contain specific policies regarding coordinated land use and transportation planning.

Water Management

More development has heightened the need to address the issues of water management. Urbanization affects water in two ways: by creating additional demands on clean and sewer water systems, and by increasing the amount of impervious surfaces, in the form of structures, roads, sidewalks, and parking lots, that produce stormwater runoff.[19] Stormwater runoff picks up pollutants on its way to Florida's canals, lakes, rivers, and estuaries. Provisions of the 1987 amendment to the Clean Water Act and Chapter 403 of the Florida Statutes provide a comprehensive regulatory framework for stormwater management.[20]

Florida law states that local governments can order developers to design their developments to keep runoff onsite.[21] Hence, many new suburban developments utilize retention and detention ponds, flow attenuation techniques, and lakes to fulfill stormwater management requirements. While serving as a stormwater system, these lakes also serve as an amenity adding value to the development. They also separate land uses and development, resulting in a longer, more complex roadway system. Regional water management districts regulate all water related issues, except navigation.

Local Land Use Planning

In Florida, local land use planning is accomplished through the local comprehensive plan and the local zoning codes. Florida is one of a handful of states to require that local land development regulations (LDRs) in the form of zoning and site planning tools be

consistent with local, regional, and state policies. The state also enables local governments to fund and plan redevelopment through a variety of legal tools.

The Local Comprehensive Plan

The local comprehensive plan (LCP) has been mentioned often in this document since it is a very important tool in land use and transportation planning. The LCP contains policies and plans that guide the planning elements required in Rule 9J-5, including land uses and urban design. The LCP includes a Future Land Use Map (FLUM) and a Future Trafficways Plan, the latter of which was mentioned in the corridor management section of this report. The FLUM designates the location of land uses by category. These categories are more general than zoning categories and include a variety of uses that are normally considered compatible. For example, schools and churches are allowed within areas designated as residential on the FLUM, while they are not allowed within areas designated as industrial. Existing land uses do not necessarily conform with the future land uses. The FLUM serves as a document to guide decisions regarding future land use changes.

Another feature of LCPs in metropolitan areas is the location of activity centers. Enabled by state law, activity centers are urban centers where the metropolitan government proposes to focus transportation and investment in other urban services to permit and promote higher intensities of uses. The Miami-Dade LCP, for example, has three levels of activity centers, Metropolitan, Regional, and Community Urban Centers. These are located in areas where there is access to several modes of transportation including fixed-guideway transportation (Miami Metro). LCP policies allow maximum local densities here and promote a mix of uses, including residential.

The Zoning Code and Map

The zoning code provides districts where certain standards and regulations apply. These requirements regulate the type and location of land uses and their

intensity, bulk requirements for structures, lot size and setbacks, signage, and landscaping requirements, among others. The map that accompanies the code, indicates the zoning designation for each property. Since the 1920s when zoning codes first appeared in the nation, these regulations have been used to manage urban development.

Elements of the Zoning Code that Affect Land Use and Transportation

Uses permitted. The zoning code lists the types of land uses and activities allowed in each zoning district. This technique has been criticized because it essentially separates and segregates land uses by category. Common zoning districts include multiple levels of residential density, commercial, industrial, institutional, and open space. In Florida, zoning codes rarely allow mixing uses within the same structure or on the same site. When they do, more often than not, residential uses are excluded from the formula. By excluding residential uses from commercial areas and vice versa, the result is downtowns abandoned at night and dormitory residential areas. This type of relationship adds vehicle trips to the roadway network.

Bulk requirements, lot size, and setbacks. Building height and width, massing, and floor height are bulk requirements. Typical suburban development limits building heights and requires larger setbacks, which directly affect density and intensity of use. Another density controller is lot size. While large lot requirements are often used to maintain densities low in semirural areas, it is not an appropriate tool for promoting transit, since it precludes appropriate densities from being achieved.

Parking requirements. Offstreet parking regulations have played a significant role in shaping urban form in Florida. Parking requirements vary by land use. Generally, minimum standards are applied to the square footage of business and industrial uses, while a discrete number of spaces applies per home or apartments. Also, many local zoning ordinances maintain parking space provisions that are based on older, larger vehicle types. Mall developers often supply significantly more parking space than

required. The placement of these large paved spaces in front of the building they serve is a deterrent to pedestrian activity on the streets.

Density. In Florida, density is regulated through the local land use plan and implemented through the zoning code. The writers of the Standard State Zoning Enabling Act of the early 1920s believed that zoning regulation would "prevent overcrowding of land and make possible the creation of one family districts."[22] This idea gained momentum due to the industrial revolution and deteriorating conditions of the city. The problems of low density became apparent with increases in land prices and financing infrastructure. Today, advocates say it is more practical to have higher rather than lower density development. Higher density, smaller lots, and reduced setback requirements, allow for less road pavement and more sidewalk area per unit. Infrastructure costs become lower as it possible to spread the costs over a larger amount of units per area.[23]

Landscaping. Today, municipalities have implemented stricter landscaping codes to combat the effects of early development, where scores of acres of native plants were destroyed, sometimes replaced by water loving vegetative species. The objective of most landscaping codes is to save energy, provide oxygen, and save potable water while promoting rainfall infiltration. Many local zoning ordinances require new developments to: demonstrate the location of all landscape features, indicate where vegetation of significance will be preserved, install species that will provide shade, and require less watering. In addition to being used to cool buildings, landscaping is used to provide buffers between potentially incompatible activities. In transportation projects, landscaping is used to mitigate the impact of noise from the roads, and planting trees along streets has become a popular traffic-calming technique. Landscaping is now being used to shade pedestrian pathways and parking lots.

The flip side is that landscaping areas in combination with stormwater retention techniques can also contribute to lowering densities and increasing the space between land uses. An alternative to this technique is to provide public landscaped open spaces,

and/or preserve natural open spaces in strategic locations within urban areas in combination with street trees for shade.

Reforming the Zoning Code

Communities are searching for tools to attract new, more sustainable forms of development or to attract redevelopment to older neighborhoods. However, developers and their financers tend to be conservative and are resistant to change unless they can find ways to mitigate financial risk. Local governments are trying to implement regulatory techniques that will allow flexibility in community design. In addition, they are becoming more involved in the development and redevelopment process as partners or promoters. Investing in infrastructure, creating public/private partnerships, and assembling land are techniques often used to attract private developers because they reduce risk.

Some communities are finding that their current rigid zoning codes do not allow more sustainable forms of urban development. New zoning techniques can provide flexibility, allowing more innovative forms of development, or they can be more prescriptive, requiring locally desired urban elements. The following are some of the techniques being used today to promote compact development, mixed uses, and pedestrian activity by linking transportation and land use in urban design.

Floating zones, overlays, and contract zoning. Floating zones are virtual districts that exist on paper. They cannot be located on the zoning map until the landowner or developer requests that the property be rezoned to meet the conditions required for that particular floating zone. Overlays are an additional layer of requirements that apply to a designated area within the city or county. These are often optional requirements that may apply in addition to those of the underlying zoning category. With contract zoning, cities can enter into contracts with the developer and require certain desirable terms in exchange for terms that are attractive to the developer. These flexible zoning techniques allow local governments to provide alternative zoning districts without

requiring them outright. Well designed zones or overlays contain attractive incentives for developers.

Traditional neighborhood design (TND). This town planning technique has gained support from many communities around the state. Easier to apply in areas outside of municipal boundaries, the technique is used to recreate traditional town designs and land use mixes. True TNDs provide a variety of activities, housing types, and civic spaces and require pedestrian-friendly street designs.

Transit-oriented development (TOD). TODs share many similarities with TNDs, with an added requirement, that transit and intermodal connections be provided in the design and construction of the community. TODs have been popularized in communities in Oregon and California in relation to light-rail.

In spite of what seem to be obvious benefits, these techniques have been difficult to apply in Florida. One reason may be the lack of comparative examples of well established projects for developers, financing institutions, and local governments to feel comfortable with the marketing risk. Another reason may be the lack of fundamental elements needed to support their implementation, such as the lack of transit connections for a TOD or sufficient market area for the commercial element in a TND.

Roadway Concurrency and Urban Form

Florida's Concurrency Management System was meant to be the financial planning tool to ensure that adequate public services and infrastructure would be in place "concurrent" with the impacts of new development.[24] The system consists of "a compact geographical area in which an areawide level of service (LOS) standard is applied for the purpose of meeting the concurrency requirements of Chapter 163, F.S."[25] The area is designated in a local government's comprehensive plan. However, transportation concurrency had the unintentional effect of encouraging sprawl. Developers turned to

suburban and rural areas where roads could meet the level of service requirements for their new development projects without having to incur additional costs.

In an attempt to reverse the effects of transportation concurrency requirements that discourage development in already existing urban areas, Florida implemented Transportation Concurrency Exception Areas (TCEAs). A TCEA is defined as a specific geographic area where relaxed transportation concurrency requirements apply on an areawide basis. The area must be designated in the local comprehensive plan, Rule 9J-5.0055(6), F.A.C.[26] The assumption behind TCEAs is that urban areas should be congested. Cities meeting certain density and intensity ratios are permitted to "ignore" concurrency requirements, provided that they offer other alternative modes of transportation to help mitigate the impact of increased development.

Redevelopment Tools

The state comprehensive plan contains a section dedicated to urban and downtown revitalization, in addition to policies contained in other sections directed at promoting "investments, and development and redevelopment activities which encourage efficient development" (Land Use Policy No. 1). Florida statutes contain several tools that can be used in redeveloping or revitalizing urban areas. These include, but are not limited to:

- Community Development Corporations,
- Community Redevelopment Areas,
- Community Development Districts,
- Downtown Development Areas, and
- Urban Infill and Redevelopment Areas.

These designations apply to specific areas within cities or counties and require that they be adopted by ordinance by the local government. Some designations come with the power to tax and fund activities through tax increment financing. Some allow the board of directors to apply for development grants. All of the designations require

the development of a plan and budget. In some cases the funds are used to provide infrastructure improvements or to help leverage the improvements. Since many areas include highways from the FIHS, FDOT has been involved in many of these planning initiatives.

Federal, State, Regional, and Local Land Use/Transportation Initiatives

Development within the Florida is not only affected by state regulation. Regulations, policies, and programs on the federal level trickle down to the state level and drive development patterns in the state. The federal government has implemented a livable communities initiative to assist communities to grow in ways that ensure a high quality of life and strong, sustainable economic growth. The initiative encourages compact development, pedestrian friendly communities, and less dependency on the automobile. It also encourages improving transit and supporting transit investments with appropriate land uses and urban design. The initiative provides a website that contains links to specific programs, resources, guides, and tools offered by federal agencies to assist communities.

Since the 1970s, recognition of the need to address the relationship between land use and transportation, and other growth related issues, in particular water management and environmental protection, has led to several significant state, regional and local initiatives. The most significant state legislation, Florida's Growth Management laws, was born from the Environmental Lands Management Commissions (ELM I, II, and III) who identified strategies for managing growth in the state.

In 1995, Governor Chiles designated representatives from a highly diverse group of state, regional, and local governments and agencies to discuss growth management issues in South Florida. The Governor's Commission on a Sustainable South Florida concluded that it would be necessary to "invest in the transportation system and

manage it to support sustainable development and curtail urban sprawl."[27] The transformation of South Florida's urban form requires a partnership among federal, state, and local governments; regional agencies; and the private sector ready to commit to investing in sustainable communities. This investment must take into account the inevitable impact of the transportation system on land use patterns.

An offspring of the Governor's Sustainable South Florida commission is the Eastward Ho! Initiative. Armed with funding, the commission and DCA enlisted the support of the Treasure Coast and South Florida Regional Planning Councils, to perform studies, hold regional forums, and develop strategies to deal with regional growth. The Eastward Ho! Concept redirects future growth from the vanishing greenfields in the western suburbs to existing older urban areas in the eastern edge of coast in a corridor between the rail tracks (FEC and CSX).

The initiative produced a toolbox of planning strategies that has promoted greater public participation in the planning process. Planning charrette and forums have produced urban infill and redevelopment strategies, neighborhood plans, changes to zoning codes, and altogether the beginning of a different approach towards land use planning.

In 1999 a committee was formed to focus on issues directly related to the transportation and land use relationship. In the final report, the Transportation and Land Use Study Committee (TLUSC) noted that the current legislation, under Chapter 163, F.S., requires local governments to spend too much time documenting data and analysis in their local comprehensive plan so that the purpose of planning becomes more process oriented than results oriented. The current process hinders pro-active planning among governments. According to the Committee, the process-driven approach was appropriate when Florida's local governments were in the early planning stages. However, now that there is a better understanding of the implications of the role of planning at the local, regional, and state level, Florida should be moving to planning that focuses on building sustainable communities.

Also in 1999, the state legislature adopted the Urban Infill and Redevelopment Act. This law provided funding for local planning and implementation initiatives in declining urban areas designated by the local government. In order to have access to the funding, the law required that the designated area be located within a quarter mile from a transit corridor.

Trends in Transportation and Land Use Planning

Although people recognize the importance of looking for solutions beyond local boundaries, there has also been a movement toward dismantling regional levels of government. No such danger exists in FDOT district offices, since there is no lower level to deal with local issues. Local governments are afraid of yielding power, while the public is wary of creating another layer of government. Notwithstanding, the trend is to create regional decision-making bodies to implement regional solutions. One example is the Regional Transit Organization in Southeast Florida that is currently working on providing commuter services connecting Miami-Dade, Broward and Palm Beach Counties.

If the lack of a more formal, structured dialog between MPOs continues, this will create greater difficulties for managing the state's major transportation corridors. Many MPOs are linked through important transportation corridors. Apart from the Turnpike District office, there are no regional "corridor" authorities. Planning for significant corridors sometimes requires two or more FDOT districts and multiple MPOs to agree on a common vision. The lack of a formal process for dealing with this type of issue hinders timely solutions. By the time everyone is ready to agree, solutions have already become much more complicated and financially infeasible. However, there are examples of regional cooperation and political will, such as the I-4 Corridor Initiative that involves public and private interests. Although the different communities recognize that improvements to the system will have desired and undesired impacts, it is better to see

them as a part of a greater plan, than on an individual basis, where the solutions are not so easy to implement.

On the subject of coordinating land use and transportation to make them mutually supportive of solutions, there are two planning levels that require new strategies. The lack of a regional land use plan allows individual communities to permit development that may cumulatively produce regional impact to the transportation network. At issue here are the cumulative and secondary impacts. The DRI process, created to deal with developments of greater than local impact, is triggered when a single proposed development meets defined thresholds. However, the cumulative impact of many smaller individual projects does not. Local governments and communities are unprepared to mitigate these cumulative impacts. Furthermore, they are often unequipped to deal with secondary, unplanned impacts of new growth and development that is occurring beyond their boundaries. Although, the RPCs and MPOs have the "responsibility" to promote intergovernmental coordination and cooperation, they do not have the authority to require it. Land use plans are still the responsibility of local decision making, and will likely remain so.

Also at the local level, city and county governments are trying to deal with their own internal land use and transportation issues. Many recognize the need for innovative tools to create activity centers and neighborhoods that are more transit-supportive and pedestrian-friendly where people can rely less on their cars. This would be particularly useful for the elderly, the young, and other groups of people who cannot or choose not to drive. However, the only implementation tools available to local governments are their zoning and subdivision codes. Many who have tried to change parts of their code with floating zones and overlays have found that these are weak instruments for making fundamental changes because of the risk implied. These communities have determined that their outdated codes need to be revised. This costs a great deal of money and effort to achieve. Nonetheless, there are many communities that are now in the process of allocating resources to rewrite their codes.

The application of the state's concurrency doctrine has failed to achieve its premise: provide locally needed infrastructure concurrent with the development it will serve. Through Transportation Concurrency Management and Exception Areas (TCMAs and TCEAs) regulations, the state enabled communities to lower their transportation standards areawide that would allow them to permit development in desired locations. However, some of the requirements were difficult to achieve. This led communities to search for other more attractive alternatives, including relaxation of concurrency requirements in their downtowns. Although, this strategy has created a larger congestion problem, it has also served to increase densities in activity centers and to make mass transportation alternatives more feasible.

The next regulatory trend is a spin-off from the concurrency requirement. It consists of reducing transportation impact fees as an incentive for innovations in development patterns. Any significant fee reduction can serve as an incentive for development, particularly a reduction of transportation impact fees. Orlando is promoting different types of development by factoring in the reduction of trips that result from alternative designs and land use mixes. Transportation fees are charged on the basis of number of vehicle trips produced by the proposed land uses. The parameters used in estimating transportation impact fees are based on single-occupancy vehicle (SOV) dependent development patterns and land uses.

Conclusions and Recommendations

The trend today is for state and local regulatory agencies to focus on methods that make growth and redevelopment more sustainable and "smarter." In other words, federal, state, and local governments are enabling their communities to become more livable, pedestrian friendly, and provide the public with a higher quality of life. Moreover, the focus is on development and redevelopment that allows local governments to more efficiently finance the services they must provide to their jurisdictions. An important step

in this process is coordinating land use and transportation decisions so that they are mutually supportive.

Review of different planning processes conducted by the state's agencies and departments reveals that avenues for coordinating land use and transportation planning exist. However, these avenues only run across the top and bottom rungs of the planning structure and do not bridge the divide at the regional level. At the top level, the state transportation plan must be consistent with the state comprehensive plan. This means that general policies that apply statewide are consistent with each other. At the local level, metropolitan transportation plans must be consistent with local comprehensive plans and vice versa. However, the most compelling transportation issues extend beyond local borders because commuter patterns and freight movements are not confined to map lines. Coordinating regional land use and transportation planning is needed to provide regional solutions to congestion, transportation alternatives for commuters, and supportive land use patterns to help maintain a strong state and regional economy.

FDOT's 2020 Transportation Plan contains objectives targeting the need to reduce the usage of the single occupancy vehicles. By working with local governments and their comprehensive plan objectives, FDOT plans to "promote and utilize alternatives, such as carpools, vanpools, expanded bus systems, intelligent vehicle and highway systems, high occupancy vehicle lanes, bikeways, pedestrian corridor overpasses, multi-use trails, employer incentives that encourage ridesharing, and support facilities, such as bike racks and office restrooms with showers. In addition, the Department will consider the use of flexible design standards and other techniques to achieve more livable communities." [28]

One of the 2020 FTP goals is to provide a transportation system that enhances the state's quality of life. In addition, the plan recognizes that there is an increasing demand for greater compatibility between transportation facilities and communities and that land use and transportation decisions need to be coordinated. However, the plan

falls short of explaining how this coordination will be achieved. Although FDOT is not in the business of making land use decisions, it could help local communities and regional authorities to understand the need to address the reciprocal relationship between transportation and land use through multiple planning levels, changes in the planning process, and innovations in land use planning and urban design.

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[14] Florida Metropolitan Planning Organization Advisory Council.(1997) *Orientation and Reference Manual*, 2000-2001 Edition.Wilkstrom, 1977, p. 86, as referred to in Lewis, Paul and Sprague, Mary (1997) *Federal Transportation Policy and the Role of Metropolitan Planning Organizations in California,* http://www.ppic.org/publications/PPIC105/index.html.

[15] Lewis, Paul and Sprague, Mary (1997) *Federal Transportation Policy and the Role of Metropolitan Planning Organizations in California,* http://www.ppic.org/publications/PPIC105/index.html.

[16] Eleven required elements includes traffic circulation, mass transit, and ports and related facilities, as separate elements. However, Rule 9J-5 requires that where the jurisdiction of the local government is contained entirely within an MPO, the three elements are contained under one general title—" Transportation Element"--that should be consistent with the MPOs long range transportation plan. Moreover, where the local population is less than 50,000, mass transit and ports and other related facilities are not required elements, making it nine required elements for those jurisdictions. School concurrency is an optional element.

[17] Department of Community Affairs, Florida. (2001) http://www.dca.state.fl.us/WhatWeDo.htm

[18] Ibid

[19] NIBS Land-Use Task Force. (1990) Land Use Regulation Handbook. National Institute of Building

Sciences: Washington, DC. Pg. 40.

[20] Ibid.

[21] F.S. Chapter 170.01 b) Order the construction, reconstruction, repair, renovation, excavation, grading, stabilization, and upgrading of greenbelts, swales, culverts, sanitary sewers, storm sewers, outfalls, canals, primary, secondary, and tertiary drains, water bodies, marshlands, and natural areas, all or part of a comprehensive stormwater management system, including the necessary appurtenances and structures thereto and including, but not limited to, dams, weirs, and pumps;

[22] NIBS Land-Use Task Force. (1990) Land Use Regulation Handbook. National Institute of Building Sciences: Washington, DC. Pg. 21.

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Florida Trends and Conditions

2000 – 2001




Trends in Transportation and Water Quality

Prepared for:
Florida Department of Transportation

Prepared by:

FAU/FIU JOINTCENTER for Environmental & Urban Problems

June 2001

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Florida Trends and Conditions 2000-2001

Trends in Transportation and Water Quality

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Executive Summary

Water is Florida's most critical and most vulnerable resource. According to Florida's Department of Environmental Protection, both water quality and water quantity have emerged as the most critical issue in Florida, due to the growing population and its accompanying urban development.

Most pollutants from transportation reach water bodies through the process of run-off from roads and parking lots. During a rain event, rainwater picks up any roadway deposits and transfers them to receiving water bodies. The most common contaminants in highway runoff are heavy metals, inorganic salts, aromatic hydrocarbons, and suspended solids that accumulate on the road as a result of regular highway operation and maintenance activities. Also, the ordinary operations and the wear and tear of vehicles result in the dropping of oil, grease, rust, hydrocarbons, rubber particles, and other solid materials on the highway surface. Finally, highway runoff may contain higher concentrations of metals predominantly lead, zinc, iron, chromium, cadmium, nickel, and copper that result from the ordinary wear of brakes, tires, and other vehicle parts. The quantity of pollutants originating from highways and motor vehicles is not well understood as pollutants are hard to measure and vary by location. According to a 1996 study by the Florida Highway Administration (FHWA), highway storm water combines the worst of industrial and residential runoff in its variety and concentration of metals, particulates, and petroleum compounds.

Highway runoff also contains considerable amounts of pollutants that are not emitted by transportation but are generated by non-transportation related activities. These pollutants include fertilizers, and pesticides from yards and lawns, atmospheric deposition from other areas and fertilizers and pesticides from agriculture.

Runoff from roads is affected by both the amount and type of infrastructure (paved or unpaved surfaces), and by the amount of travel. In the case of paved roads, pavement and structures may cover soils and destroy vegetation that would otherwise slow and absorb runoff before it reaches receiving bodies of water. Research indicates that highway runoff is only significant for roads with traffic volumes greater than 30,000 vehicles per day (major freeways and urban arterials).

Another important environmental impact occurs during highway construction and results from erosion of topsoil during storms. The most important constituents of storm water runoff from construction are suspended solids. Runoff from construction sites can also cause sedimentation and other changes that disrupt aquatic habitats. Finally, construction of roads can reduce water storage and spring flow, threatening species during droughts.

Effects of Transportation on Water Quality

Water is the livelihood of the environment, essential to the survival of all living things: plants, animals, and humans. Water is both a crucial component of living organisms and the earth, with about 60 percent of the human body made up of water, and around 70 percent of Earth's surface covered with water.[1] Fresh water, however, is a scarce resource since over 97 percent of all the earth's surface water is salt water. As table 1 shows, most of the remaining 2.4 percent fresh water is locked up in glaciers, ice caps and snowfields, and not available for human use.

Table 1: Distribution of Water[2]

Source	Percentage	Average Staying Time
Oceans	97.6	3,000-30,000 years
Ice and snow	2	1-16,000 years
Groundwater	.3	Days to thousands of years
All lakes	.016	1-1000 years
Soil moisture	.005	2 weeks to a year
Plants and animals	.005	1 week
Atmosphere	.001	8-10 days
Rivers and streams	.0001	10-30 days

Water in Florida

At first glance it seems that water should not be a problem in Florida. On average, the far northwest and southeast receive more than sixty inches of rainfall per year, while the Keys receive about forty inches annually. The resulting rainwater represents a valuable component of water resources to be recovered and reused.[3]

Even though Florida receives an abundant amount of rainfall, the variability of this rainfall due to location and climatic conditions can create local

water shortages. The heaviest rainfall occurs in northwest Florida and in a strip ten to fifteen miles inland along the southeast coast. Except for the northwestern part of the state, the year contains a rainy season and a relatively long dry season. In the peninsula, half the average annual rainfall usually falls between June and September. In northwestern Florida, a secondary rainy season occurs in late winter to early spring. The lowest rainfall for most of the state occurs in fall (October and November) and spring (April and May).

According to the 2000 Water Quality Assessment Report, Florida has 51,858 miles of streams and rivers, more than 7,700 lakes with a total surface area of 3,258 square miles, and 4,298 square miles of estuaries.[4] The longest river is the St. Johns, which flows north about 273 miles from St. Johns Marsh in North St. Lucie County to its mouth at Jacksonville.[5] Lakes occupy close to 6 percent of Florida's surface, with Lake Okeechobee being the largest one in Florida and the ninth largest in surface area in the U.S.[6] All these surface waters have been classified according to their designated use, as shown in table 2.

Table 2: Water Classification in Florida

Class	Designated Use
I	Potable water supplies
II	Shellfish propagation or harvesting
III	Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife
IV	Agricultural water supplies
V	Navigation, utility, and industrial use

Adapted from main 305(b).[7]

Table 3 shows that most water bodies in Florida are designated for wildlife and recreation while less than 9 percent of the water bodies are designated for drinking water.

Table 3: Florida's Water under the Water Qualification System

Class	Designation	# Watersheds
I	Drinking Water	46
II	Shellfish Harvesting	124
III-Freshwater	Wildlife and Recreation	4,567
III-Marine	Wildlife and Recreation	388
IV	Agriculture	1
V	Industrial	0

A water body with exceptional recreational or ecological significance may also be designated as an Outstanding Florida Water (OFW). OFWs include waters in state and national parks, preserves, and sanctuaries, rivers designated as wild and scenic at federal or state levels, and "special" waters that have been designated OFW based on their exceptional environmental or recreational significance. So far, only two water bodies in Florida have been classified under this category: the Hillsborough River and the Wiggins Pasee/Coocohatchee River.

Environmental trends of water quality are very difficult to assess because there is no specific standard for water quality. The closest description of water quality trends is reported in Florida's Water Quality Assessment Reports. These reports give an assessment of overall water quality based on a large number of criteria which fall into four general categories:1) the trophic state, 2) biological data, 3) exceedances of standards for conventional pollutants, and 4) exceedances of metal standards. Each waterbody receives a score form 1 (good) to 5 (poor) for each category. Overall water quality is determined by averaging the scores in the four categories with classification ranging from good (1-2), to fair (2-4) and poor (4-5)[8]. Figure1 shows the water quality in Florida for the years 1996, 1998 and 2000.

Figure 1: Water Quality 1996, 1998, 2000

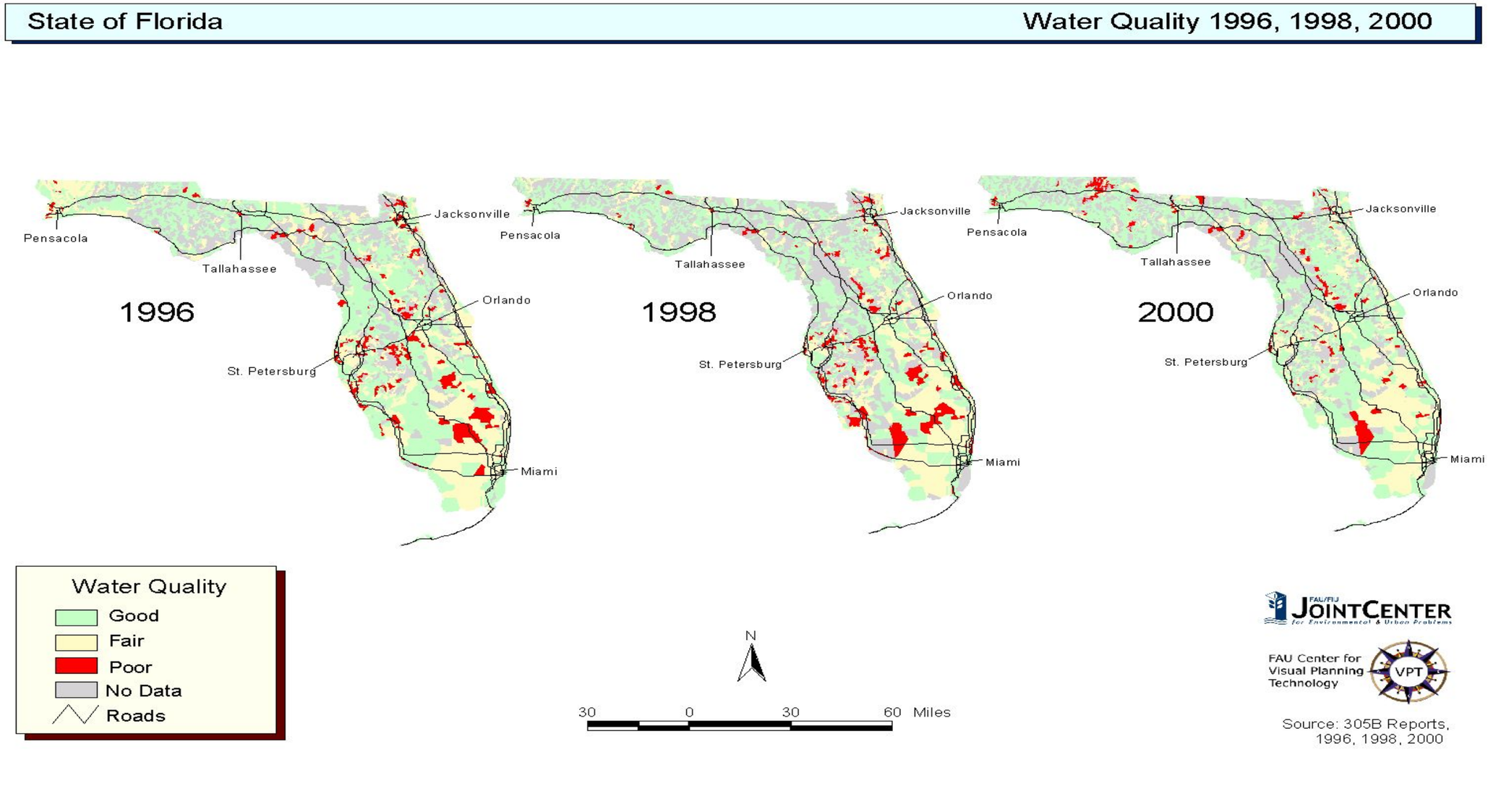


Figure 2 shows the percentage of water bodies in each category for 1996, 1998 and 2000. It is clear from this figure that for each reporting year there was only data for about half of Florida's waters and that the information for each of the reported years is not the same.

Figure 2: Percentage of water bodies that were included in the 1996, 1998 and 2000 water quality determination

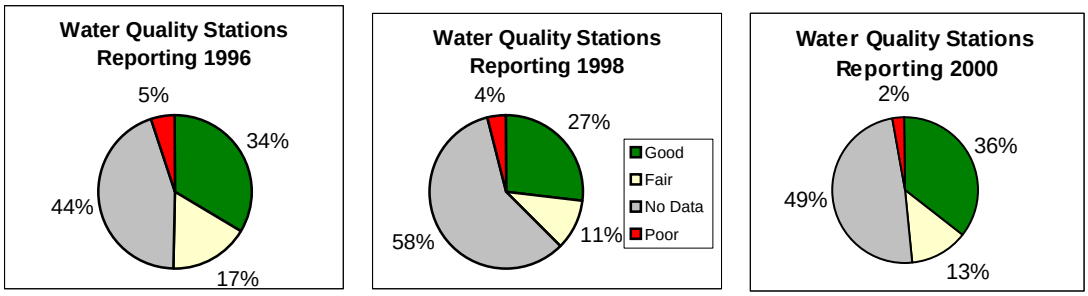
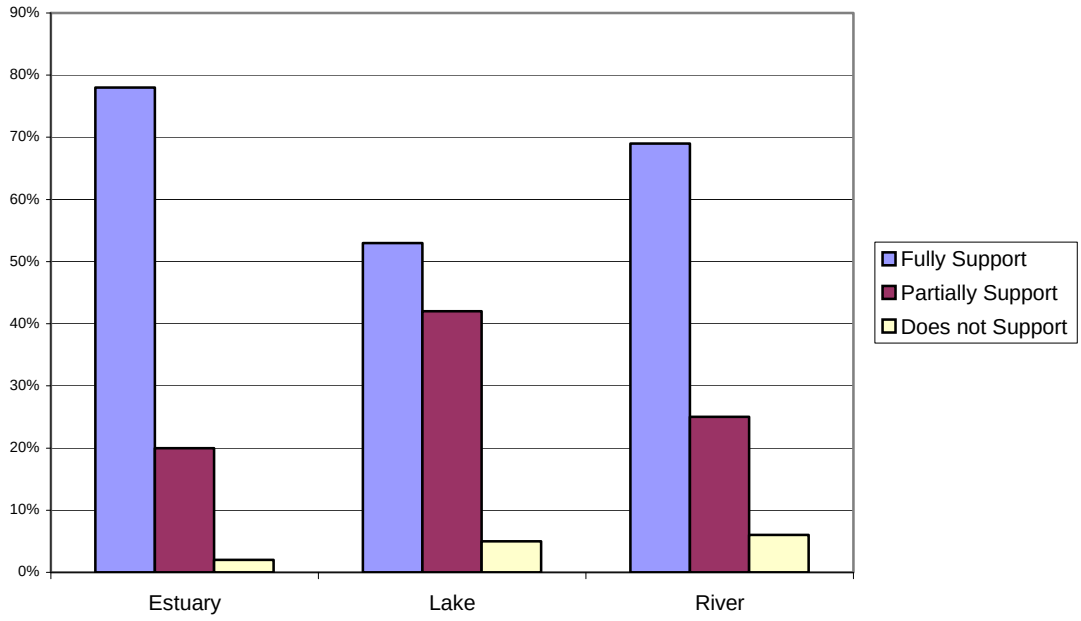


Figure 1 and 2 show that less than 5 percent of the water bodies in Florida have *poor* water quality, while about one third is qualified as having *good* water quality. Typically, the water quality in the sparsely populated northwest and west-central sections of the state is better than in other areas. Problems are evident around the densely populated, major urban centers, including: Jacksonville, Orlando, Tampa, Pensacola, Cape Kennedy, and the southeastern Florida coast. Poor water quality not associated with a large population is also found in basins with intense agricultural and industrial use[9]. It is important to realize that for all three years there was no data available for about half of the waterbodies. Besides the lack of data, the methodology for calculating water quality is far from perfect. There are fish advisories for most fresh water areas in the Everglades, limiting fish consumption to one meal a month or less, due to high mercury concentrations. Since this area scores well on the other criteria, water quality in most of the Everglades is still rated as *good* or *fair*.

Another way of reporting water quality is by designated use. Figure 3 shows that, according to the 2000 Water Quality Assessment Report, most of Florida's water bodies meet their designated use and most of the water bodies

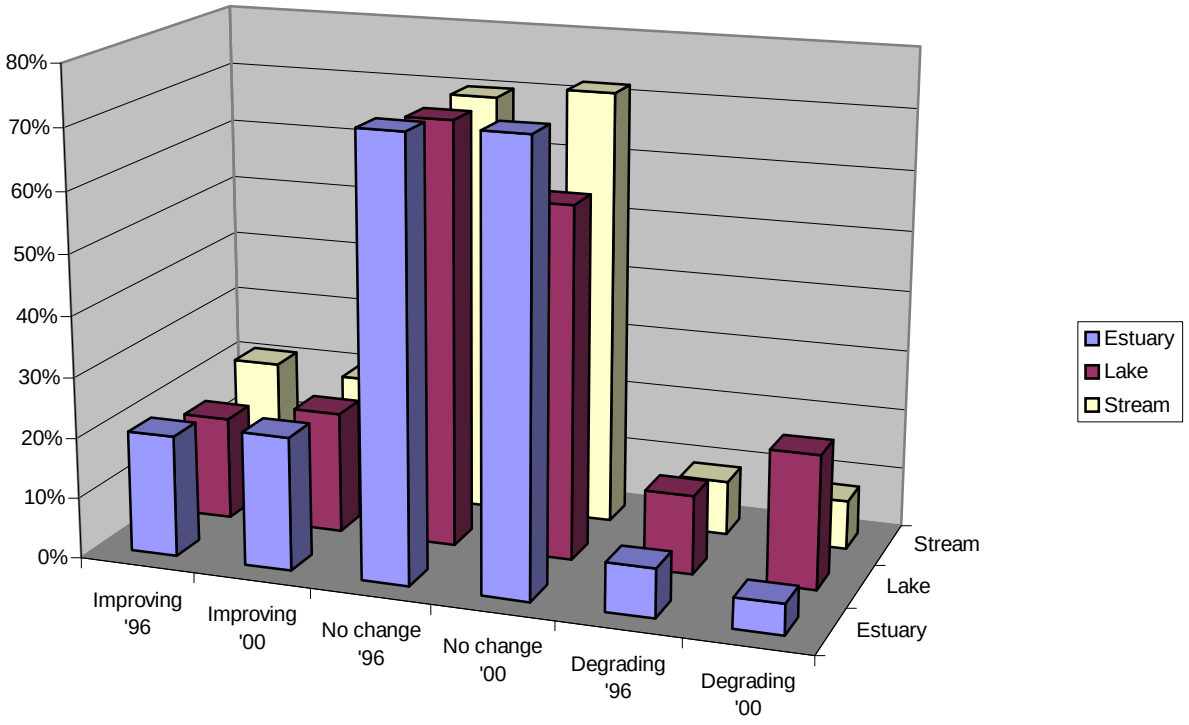
that do not meet their designated use are located in the highly urbanized sections of central and southern Florida.

Figure 3: Support of Designated Use by Florida's Water Bodies[10]



Aside from actual water quality, changes in over time water quality provide valuable information about the health of surface waters. Figure 4 shows trends in water quality for 945 water bodies (out of a total of approximately 5000). The figure shows that 72 percent of the water bodies in the study showed neither significant improvement or degradation, while 20 percent showed improvement and 8 percent showed degradation. The improvements generally resulted from wastewater treatment plant upgrades or new regional wastewater plants and nonpoint source controls in Tampa, Orlando, and several other cities[11]. The difference in the numbers of water bodies that showed no change, degradation, or improvement, from 1996 to 2000 is not significant.

Figure 4: Changes in Water Quality in Florida for 2000.[12]



Threats to Water Quality and Quantity

Water is both the state's most critical resource and its most vulnerable one. Florida's economy depends on the availability of clean fresh water, not only for the $7 billion fishing and $32 billion tourism[13] industries, but also for the $20 billion a year agricultural sector[14]. According to the Florida Department of Environmental Protection (FDEP), the pressures of population growth and its accompanying development present serious problems and both water quality and quantity have emerged as the most critical issues for the coming decades[15].

According to FDEP, the major surface water problems in Florida fall into five general categories:[16]

1. Urban storm water. Storm water carries many different pollutants, from nutrients to toxic pollutants, and adds biochemical oxygen demand. As a major

nutrient source, it accelerates eutrophication. Urban storm water, siltation, and turbidity from construction activities are major sources of impairment for all water body types. Problems concentrate around the state's urban centers.

2. Agricultural runoff. Major agricultural pollutants include nutrients, sediments (increased turbidity), biochemical oxygen demand, bacteria, and pesticides. These pollutants generally have the greatest impact on lakes, slowly moving rivers and canals, and sometimes receiving estuaries. Agriculture is a major source of impairment for all water body types. Problems are concentrated in the central and southern portions of the state and in several rivers entering Florida from Georgia and Alabama.

3. Domestic wastewater. Domestic wastewater contributes nutrients, pathogens and can be a source of toxic pollutants. Sources include municipal wastewater treatment plants, package plants, septic tanks, and runoff from land application sites. Because of improvements in water treatment facilities most problems in urbanized areas have been successfully addressed. However, problems exist in rural areas where several poorly operating facilities continue to pollute relatively pristine waters.

4. Industrial wastewater. Major industrial wastewater sources in Florida include phosphate mines, fertilizer manufactures, and pulp and paper mills. Industrial discharges contribute about 10 percent to the total miles of impaired waters.

5. Hydrologic modifications. This category includes damming running waters; channeling slowly moving waters; or dredging, draining, and filling wetlands for flood control, agriculture, drinking water supplies, and urban development. While such modifications are not strictly pollution sources, in most cases where natural hydrologic regimes are modified, water quality problems ensue. Dredging and filling destroy habitats. Disrupting wetlands and causing a net loss in their areas

reduces buffering and filtering capacities and biological potential. This is a particularly important problem in estuaries.

Besides these pollution related problems, Florida's water supply is threatened by the increasing water use of Florida's burgeoning population. In 1950, the state's population of 2.8 million used about 2.9 billion gallons per day. By contrast, in 1990, its 13 million people used 7.5 billion gallons of fresh water daily, of which ground water provided about two-thirds. Although the state has extensive water resources, most Floridians live in coastal areas where less fresh water is available.

Water Management

The Clean Water Act is the nation's primary mechanism for protecting and improving water quality. The purpose of this Act is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters," and its emphasis is to declare unlawful the unregulated discharge of pollutants into all waters of the United States.[17] Besides the Clean Water Act, there are several number of regulations that protect water quality. Table 6 lists some of the Federal Programs, which need to be incorporated into storm water management planning considerations:

Table 6: Regulatory Framework

Federal Programs
National Environmental Policy Act (NEPA)
Clean Water Act: National Pollutant Discharge Elimination System (NPDES).
Clean Water Act: Nonpoint source Pollution Control Programs (Section 319)
Coastal Zone Act Reauthorization Amendments (CZARA)

Congress enacted the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) to address several concerns, one of which was the impact of nonpoint source pollution on coastal water. One of the main purposes of CZARA

is to strengthen the links between Federal and State coastal zone management and water quality programs and enhance state and local efforts to manage land use activities that degrade coastal waters and coastal habitats.[18] Table 7 lists CZARA Management measures for urban areas.

Table 7: CZARA Management Measures for Urban Areas

Management Measures
Roads, highways, and bridges
Runoff from developing areas
Runoff from construction sites
Runoff from existing development
On-site disposal systems
General sources (households, commercial activities, and landscaping)

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) includes measures and policies requiring or encouraging an approach to transportation development, which integrates considerations for management of both the natural and constructed environments. ISTEA, through measures in the Transportation Improvement Program, encourages Metropolitan Planning Organizations and local, and state transportation agencies to involve the public and other resource management and development concerns in long-range transportation planning.

It also requires that transportation agencies consider the likely effects of transportation policy decisions on land use and development, and the consistency of transportation plans and programs with the provisions of all applicable short- and long-term land use and development plans. In a sense, these provisions incorporate an ecosystem approach into highway planning, resource development and land-use by moving land use decisions to the front end of the transportation planning process. This should encourage better decision-making processes and long range planning for both transportation and land use development, compatible with sustainable ecosystem productivity and integrity.

ISTEA provides clear and specific authority for advance inventory of wetlands resources, participation in local and regional planning efforts for management of wetlands ecosystems, and development of mitigation banks for mitigation of unavoidable wetlands impacts. It also establishes the eligibility of mitigating impacts on other natural ecosystems and wildlife habitat for Federal-aid funding. All of these approaches support an ecosystem management concept.

In response to mounting evidence indicating that air pollution contributes significantly to water pollution, congress added the Great Waters Program (section 112(m)), and the Air Deposition control program (Title IV) when it amended the Clean Air Act in 1990.

All facilities that discharge wastes into Florida waters are reasonably expected to be a source of water pollution and are regulated under FDEP's Wastewater Permitting Program. Permits issued under this program for discharges to surface waters also serve as the National Pollutant Discharge Elimination System (NPDES) permit for the facility. Permits containing effluent limitations must be obtained to build, operate, and modify domestic and industrial wastewater facilities. Florida contains 5,111 NPDES permitted facilities. Of these, 641 are permitted to discharge to surface waters, and an additional 255 discharge to surface waters under general permits. To improve water quality further, FDEP is encouraging the reuse of treated wastewater (primarily for irrigation) and wetlands discharge. Currently, eighteen wetlands treatment systems are operating in the state.

The state also has an active Nonpoint Source Program. At the core of this program is FDEP's Stormwater Rule and supporting 1989 stormwater legislation. The regulations require all new developments to retain the first inch of runoff in ponds that are designed to remove 80 to 90 percent of pollutants before they enter surface waters. The program is also integrated with the state's Surface

Water Improvement and Management Act (SWIM), as well as the Comprehensive Planning Act. The program actively supports, via 319 Program grants, the development of Best Management Practices to control nonpoint source pollution. Current contracts focus on the development of Best Management Practices (BPM) for other nonpoint sources such as agriculture, septic tanks, landfills, mining, and hydrologic modifications.

Water in Florida is protected under Chapters 403 and 373, Florida Statutes (F.S.), which define the authority for preventing pollution and managing water resources. Both the Water Quality Assurance Act and SWIM address water resource planning and the restoration of degraded waters. The Florida Department of Environmental Protection has introduced an ecosystem management approach to water quality, which allowed the state to evaluate impacts to a watershed in a comprehensive, integrated way, rather than simply reviewing individual permit requests. To keep control of water quality and quantity, Florida is divided into five water management districts:

1. The Northwest Florida Water Management District;
2. The Suwannee River Water Management District;
3. The St. Johns River Water Management District;
4. The Southwest Florida Water Management District; and,
5. The South Florida Water Management District.

Each of the water management districts is responsible for both water quality and water quantity in their watershed. This approach balances the need for consistent statewide regulations with regional flexibility.

Effects of Transportation on Water

The effects of transportation on water quality can be categorized according to the source of pollution. Table 8 shows the different constituents originated from transportation according to the following sources of pollution:

1. Transportation Devices
2. Transportation Facilities
3. Combination of Devices and Facilities
4. Construction

Table 8: Facilities, Devices, Combination, and Construction (Adapted from EPA)[19]

Type	Constituent	Source
Facilities	Iron	Steel highway structures such as bridges and guardrails.
	Nickel	Asphalt Paving.
Devices	Particulates	Vehicles, atmospheric deposition.
	Lead	Leaded gasoline from auto exhaust.
	Zinc	Motor oil and grease.
	Iron	Auto body rust.
	Copper	Metal plating, bearing and brushing wear, moving engine parts, and brake lining wear.
	Chromium	Metal plating and brake lining wear.
	Nickel	Diesel fuel and gasoline, oil.
	Manganese	Moving engine parts.
	Sulphates	Fuel.
Combination	Particulates	Pavement wear.
	Zinc	Tire wear.
	Cadmium	Tire wear.
	Nickel	Asphalt paving.
Construction	Particulates	Maintenance activities
	Copper	Fungicides and insecticides.
	Cadmium	Insecticide application.

Run-off

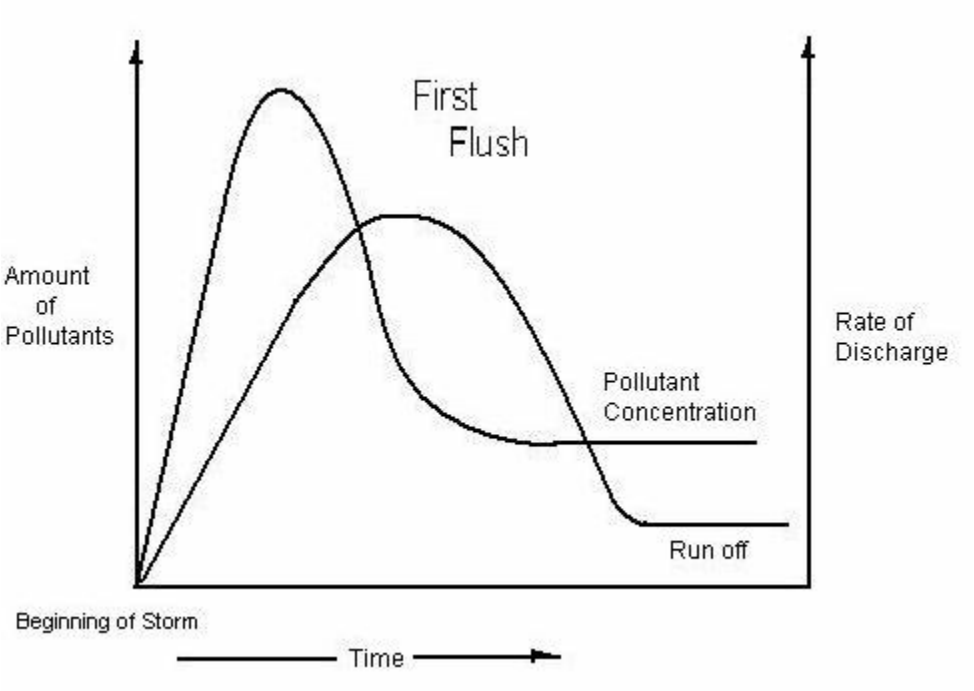
Although it is possible to identify the specific source for each pollutant, most pollutants from transportation reach water bodies through the process of run-off

from roads and parking lots. Highway contaminants are deposited on roadway surfaces, median areas, and rights-of-way from atmospheric fallout, fuel combustion processes, lubrication system losses, transportation load losses, and paint from infrastructure. During storm events, rainwater first washes out atmospheric pollutants, then, upon surface impact, picks up roadway deposits, after which it runs off into receiving water bodies.

The most common contaminants in highway runoff are heavy metals, inorganic salts, aromatic hydrocarbons, and suspended solids that accumulate on the road as a result of regular highway operation and maintenance activities. Also, the ordinary operations and the wear and tear of vehicles result in the dropping of oil, grease, rust, hydrocarbons, rubber particles, and other solid materials on the highway surface. Finally, highway runoff may contain higher concentrations of metals predominantly lead, zinc, iron, chromium, cadmium, nickel, and copper that result from the ordinary wear of brakes, tires, and other vehicle parts.[20] At the same time, highway run-off contains pollutants that are not emitted by transportation but are generated by non-transportation related activities. These pollutants include fertilizers, and pesticides from yards and lawns, atmospheric deposition from other areas and fertilizers and pesticides from agriculture.

Studies in Florida have determined that the first one-inch of runoff generally carries 90 percent of pollution from a storm.[21] Figure 5 shows the relationship between the amount of pollutants and the time of the storm.

Figure 5: First Flush



The quantity of runoff generated depends on the frequency, intensity, and duration of precipitation in an area. The water quality characteristics of runoff are affected by local air quality (because of deposition of air pollutants onto roads) and, to some extent, the level of traffic activity. The quantity of pollutants originating from highways and motor vehicles is not well understood as pollutants are hard to measure and vary by location. According to a 1996 study by the Florida Highway Administration (FHWA), highway storm water combines the worst of industrial and residential runoff in its variety and concentration of metals, particulates, and petroleum compounds.[22] However, highway storm water is generally cleaner than runoff from other non-point sources such as buildings, farms, mines, and harbors.[23]

FHWA research, in the 1970s, on highway runoff water quality found that runoff had significant effects only from highways with traffic volumes greater than 30,000 vehicles per day (major freeways and urban arterials). In a report for the US EPA, Driscoll showed the relationship between pollutant load and average

daily traffic (ADT), based on monitoring results from over 900 storm events in 31 states[24]. Table 9 shows that Driscoll's results suggest that ADT influences concentrations of nutrients, metals, particulates, and chemical oxygen demand (COD).

Table 9: Pollutant Concentration and Average Daily Travel [25]

Pollutant	Urban (ADT>30,000)	Rural (ADT<30,000)
Total Suspended solids	142	41
Volatile Suspended solids	39	12
Total Organic Carbon	25	8
Chemical Oxygen Demand	114	49
Nitrate+Nitrite	0.76	0.57
Total Kjeldahl Nitrogen	1.83	0.87
Phosphorus (as PO4)	0.40	0.16
Total Copper (Cu)	0.054	0.022
Total Lead (Pb)	0.40	0.080
Total Zinc (Zn)	0.329	0.080

Driscoll,[26] concluded that paved roadways with ADT greater than 30,000 produced runoff with 2 to 5 times the pollutant levels present in runoff from rural highways. The study also noted that individual highway sites within each category (urban or rural) were shown to have different pollutant concentrations and correlated poorly with traffic density.[27]

According to a 1988 storm guide from the Florida Department of Environmental Regulation, runoff from roads is affected by both the amount and type of infrastructure (paved or unpaved surfaces), and by the amount of travel. In the case of paved roads, pavement and structures may cover soils and destroy vegetation that would otherwise slow and absorb runoff before it reaches receiving bodies of water.[28] In a 1981 study for the FHWA, Grupta found that the

nature and extent of pollutant accumulation is affected by the following variables.[29]

- Traffic characteristics (volume, speed, braking).
- Climate conditions (intensity and form of precipitation, wind, temperature).
- Maintenance policies (sweeping, mowing, repair, herbicides).
- Surrounding land use (residential, commercial, industrial, rural).
- Percent pervious and impervious areas.
- Age and condition of vehicles.
- Anti-litter laws and regulations covering vehicle emissions.
- Use of special additives in vehicle operation.
- Vegetation types on the highway right-of-way.
- Accidental spills.

Recent publications by the EPA show there is mounting evidence indicating that air pollution contributes significantly to water pollution through the process of atmospheric deposition. Atmospheric deposition occurs when pollutants in the air fall on the land or water. Air pollution can be deposited into water bodies either directly from the air onto the surface of the water, or through indirect deposition, where the pollutants settle on the land and are then carried into a water body by runoff. Any chemical that is emitted into the air can become an air deposition problem. The most common chemicals in air deposition are nitrogen, mercury, copper, polychlorinated biphends (PCBs), polycyclic aromatic hydrocarbons (PAHs), chlordane, dieldrin, lead, lindane, polycyclic organic matter (POM), dioxins, furans, toxaphene, hexachlorobenzene, hexachlorocyclobenzene, and diazanon.

It has been estimated that anthropogenic mercury emissions have tripled the mercury concentration in the air and in the surface of the ocean since 1900.[30] Also, depending on the water body and watershed being considered, it is

estimated that roughly a quarter of the nitrogen in an estuary comes from air sources.[31]

Construction

New construction, as defined by the US DOT, includes any draining, dredging, filling, diking, impounding, and related activities.[32] Most of the more important environmental impacts of highway construction result from erosion of topsoil during storms. Erosion is a naturally occurring process that is accelerated by human activities. Erosion is often described as the detachment of soil particles by some force or forces, which can be rainfall, wind, or other forces. The most common cause of erosion is rainfall, which is a function of climate, soil, topography, and vegetative cover.[33] Climatic conditions, for example, have both a direct and indirect impact on erosion. The most direct impact is due to rainfall intensity and duration. A very intense rainfall of short duration is more damaging than a longer, less intense rainfall.[34]

The most important constituents of storm water runoff from the construction corridor are suspended solids. Other solid related parameters such as turbidity and iron are also important.[35] Runoff from construction sites can also cause sedimentation, and other changes disrupting aquatic habitats. Suspended solids reduce the aquatic food supply by blocking light and reducing photosynthesis.[36] Construction of roads can also reduce water storage and spring flow, threatening species during droughts.[37] Highway construction has also been cited as an activity that contributes to wetlands destruction and loss of mangroves, seagrass, marshes, and swamps.[38] Wetlands are essential to over half of the endangered fish species and half of the endangered amphibian species in the U.S. [39] At the same time, wetlands act as both chemical and biological scrubbers of water flowing through them. Wetlands are an integral part of the regional hydrologic system reducing downstream peak flows during flood periods and maintaining base flows during dry periods.[40]

Highway maintenance is a part of construction, and even though it is an ongoing activity, it has a low potential for significant water quality impacts. Most highway maintenance practices have no potential to impact water quality. For those that have a possible or probable impact, most can be minimized or reduced through the use of readily available control technologies or through improved Best Management Practices (BMP).[41] According to the EPA, the negative impact of highway construction on the quality of surface water is often significant despite improvements in the technologies used for erosion and sediment control.[42]

Conclusion

The most important impact of transportation on water quality is in the form of storm water run-off. According to FDEP, storm water is the major source of pollutants to Florida's lakes, estuaries, and streams.[43] Cleaning up storm water run-off is difficult since there are many different sources that are well out of control of transportation planners. The only real solution is to collect all storm water run-off and treat it before it is released to the environment.

The second important source of water pollution occurs during the construction of transportation facilities. Fortunately, problems during construction can be greatly reduced by using best management practices.

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